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Soil and Water Conservation

Number 33

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The classification of articles follows the table of contents used for the "Soil and Water Conservation Research Needs" of the Soil Conservation Service. Abstracted articles are not editorialized and the language of the author is used wherever possible. In foreign articles, the units of measure are converted to usual American units. Tables are included where they help to present the information. When the entire number of a publication is devoted to reviewing one subject then the entire publication is abstracted as one article giving title and authors of each paper included in the publication. Abbreviations of journals and addresses follow U.S.D.A. Misc. Pub. 765, July 1958.

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Charles B. Crook, Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Plant Industry Station, Beltsville, Maryland, 20705.

CONTENTS

	Index Number	Page Number
WATERSHED ENGINEERING		
Watershed development	1-3	1
Hydrology	4-26	2
Geology	27-29	8
Engineering design	30-38	9
Snow surveys	39	12
Ground water recharge	40	12
WATER MANAGEMENT		
Irrigation	41-53	13
Drainage	54-57	18
Storage and conveyance	58-62	20
BASIC SOIL SCIENCE		
Soil physics	63-78	23
Soil chemistry and mineralogy	79-89	30
Soil biology	90-93	34
Soil plant-animal relationship	94-113	35
Soil classification	114-128	44
EROSION CONTROL		
Erosion equation	129	51
Wind and water erosion	130-132	51
SOIL MANAGEMENT		
Cropping practices	133-135	53
Crop residue management	136-138	54
Tillage	139-146	56
Fertility requirements for conservation farming	147-181	60
Salinity and alkali problems	182-190	66
Cover crops and green manure crops	-	70
Climatic influences	191-196	70
Surface soil removal	197	73
Mulching	198-203	73
PLANT MANAGEMENT		
Pasture and haylands	204-207	76
Rangelands	208-214	78
Plant materials	215	81
Woodlands	216-227	82
Windbreaks	228-231	87
Management of coffee plantations	232	89
Fruit and nut crops	233-241	89
Field crops	242	93
Vegetable crops	243-245	94

	Index Number	Page Number
ECONOMIC AND SOCIAL ASPECTS OF SOIL CONSERVATION		
Costs and returns.	246-247	95
Institutional, educational, and social factors affecting conservation application.	248-251	97
BIOLOGY		
Fish.	252-258	99
Upland wildlife.	259-276	102
Wetland wildlife.	277-281	109
SUPPLEMENT		
Problems indirectly affecting the application of soil and water conservation practices.	282-286	112
Radioactive fallout	287-292	115

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WATERSHED ENGINEERING

Watershed Development

SEE ALSO 24, 30, 131.

1. Hobbs, H. W. HYDROLOGIC DATA FOR EXPERIMENTAL AGRICULTURAL WATERSHEDS IN THE UNITED STATES 1956-59. U.S. Dept. Agr., Agr. Res. Serv. Misc. P. 945, irregular pp. 1963.

Selected hydrologic data for the calendar years 1956-59, inclusive, were presented. Monthly precipitation and runoff data for 157 watersheds, annual maximum discharges and annual maximum volumes of runoff for 142 of the watersheds for time-intervals of 1, 2, 6, and 12 hours and for 1, 2, and 8 days, and detailed information for one or more selected typical storm events for 134 of them were given. The data include additional information on watersheds reported in three publications of somewhat similar titles published by the Soil and Water Conservation Research Division in 1957, 1958, and 1960 and data on 45 new watersheds.

Information on selected storm events includes: (1) Tabular data for the 30-day antecedent rainfall and runoff prior to the events, and for the storms; (2) data on rainfall and runoff intensity or rate and on accumulated depths of rainfall and runoff; (3) description of watershed conditions at the time of the selected events; (4) graphs of hydrographs and rainfall histograms; (5) watershed maps; and (6) for some of the larger drainage areas, isohyetal maps of storm rainfall distribution.

For newly established watersheds, descriptions of watershed physical characteristics, instrumentation, graphs, maps, land management, and recommended area of application of the results were given.

Tables, charts, and maps.

SWCRD, ARS, USDA, Beltsville, Md., 20705

2. Wallis, J. R., Bowden, K. L., and Lent, J. D. AREA BURNED BY WILDFIRE IN CALIFORNIA WATERSHEDS, 1940-1959. U.S. Forest Serv. Res. Note PSW-30, 22 pp. 1963.

Uniform fire histories (1940-59) were compiled for 522 watersheds and 110 hydrographic regions. With a few exceptions, the compilations include all fires, over 100 acres in size, reported to the major California firefighting agencies. The data sources, limitations, and availability were discussed. Characteristics of the fire inventory were explained and illustrated, and a summary of watershed data presented.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

3. Lusby, G. C., Turner, G. T., Thompson, J. R., and Reid, V. H. HYDROLOGIC AND BIOTIC CHARACTERISTICS OF GRAZED AND UNGRAZED WATERSHEDS OF THE BADGER WASH BASIN IN WESTERN COLORADO, 1953-58. Geol. Survey Water-Supply Paper 1532-B. 73 pp. 1963.

The hydrologic and biotic characteristics of small drainage basins on the Colorado Plateau and the effect of grazing on these characteristics have been studied since 1953.

Periodic observations were made at permanent transects in 8 paired fenced and unfenced watersheds to characterize plant and ground cover, determine degree of use by

livestock, and measure changes in watershed cover. After 5 years, changes in watershed cover were relatively small on both grazed and ungrazed areas. Changes that did take place were mainly on shale and mixed type soil. Ground-cover index on mixed type soil was significantly higher, 4 percent, on ungrazed areas than on grazed areas at the end of 5 years.

Plot records were obtained using the Rocky Mountain Infiltrometer at 12 plots in each of the 8 study watersheds to determine the effect of livestock exclusion on infiltration and sheet erosion. Infiltration rates for the last 20 minutes of both the wet and dry runs were insignificantly higher in 1958 than they were 5 years before, but this difference was not associated with treatment because rates on both grazed and ungrazed plots increased about the same amount. The initial water-absorbing capacity increased significantly on ungrazed plots. No change in erosion rates was observed.

Rainfall was variable and below normal during 4 of the first 5 years of study. Runoff was produced mainly by thunderstorms during the summer months and was characterized by high rates of flow for short periods. Comparison of runoff in grazed and ungrazed watersheds indicates a change in the relation between precipitation and runoff because of exclusion of livestock. More sediment per unit area was produced during the 5 years of study from grazed areas than from ungrazed areas.

No definite trend in small mammal population on grazed and ungrazed watersheds was determined.

For sale by Supt. Doc., U.S. Govt. Printing Off., Washington, D.C., 20402

Hydrology

SEE ALSO 1, 2, 3, 32, 33, 34, 40, 77, 132, 214.

4. Thompson, C. B. STUDY OF MUNICIPAL AND IRRIGATION WATER SHORTAGES. J. Irrig. and Drain. Div., ASCE 89 (IR 4): 7-13. Dec. 1963.

An analysis of water shortages for municipal and industrial, and (project type) irrigation uses were presented. Data on water shortages for these uses were compiled and general practical guides for use in planning studies by governmental agencies and consulting firms were established. It was concluded that shortages of any magnitude should not be permitted in studies in which water is to be supplied for municipal and industrial purposes. No firm guides and limitations based entirely on water shortages were recommended for irrigation use. Economic analyses will be made for irrigation, on a project by project basis, that will consider reduced crop yields due to water shortages. Desirable limits on water shortages for irrigation in planning work were considered to be as follows: Maximum average annual for 50-yr. period, 3 percent; maximum for a single year, 50 percent; maximum for 2 consecutive years (total), 70 percent; and maximum shortage years, 27 percent.

U.S. Agency Internatl. Develop., Tunis, Tunisia.

Soil Conserv. 29(3): 51-71. 1963.

This issue of Soil Conservation was devoted to the conservation of water. The following articles were given:

5. Williams, D. A. OUR UNSEEN WATERS. SCS, USDA, Washington, D.C., 20250
6. Bannister, S. PALOUSE FARMER'S ALFALFA-AND-GRASS SAVES MOISTURE--CONTROLS EROSION. SCS, USDA, Colfax, Wash.

7. Brown, W. J. WATER-THE "STUFF THAT KEEPS THEM GOING". SCS, USDA, Ignacio, Colo.
8. Lee, R. E., and Amundson, A. J., Jr. KICKAPOO CONSERVATION ORCHARDS BRING PEOPLE AND MONEY TO VALLEY. SCS, USDA, La Crosse, Wis.
9. Woodruff, C. B., Jr. "BEDDED" LANDS SOLVE NEW YORKER'S HAY PROBLEM, SCS, USDA, Plattsburgh, N.Y.
10. Wadleigh, C. H. OUR SOIL-MOISTURE RESERVOIR. SWCRD, ARS, USDA, Beltsville, Md., 20705
11. Worthington, E. L. WINDBREAKS: REDUCE EVAPORATION--HOLD SNOW--LESSEN WIND EROSION. SCS, USDA, Bismark, N. Dak.
12. Merrill, C. L. and Hatch, W. B. UTAH IRRIGATED AREA PROFITS FROM MODERN SOIL-WATER MANAGEMENT, SCS, USDA, Delta, Utah.
13. Johnson, J. A. SOUTHEASTERN STATES MOVE OUT ON SURFACE-GROUND WATER PROBLEMS. SCS, USDA, Spartanburg, S.C.
14. Uhlig, H. G. MINNESOTA FARMERS DEVELOP WATER FOR RECREATION AND WILDLIFE, SCS, USDA, St. Paul, Minn.
15. Hubbard, L. R. STEEL BARREL RISERS CUT COST OF UNDERGROUND IRRIGATION SYSTEM. SCS, USDA, Ely, Nev.
16. Achtermann, A. SEEPY-PASTURES SPRINGS PAY OFF FOR OHIO FARMERS. SCS, USDA, Millersburg, Ohio.
17. Cole, S. "MOISTURE ACCOUNTING" METHOD FOR IRRIGATION TOBACCO GROWERS. SCS, USDA, Chase City, Va.
18. Odell, H. H. CONSERVATION FARM POND WATER USED TO FIGHT MILL FIRE. SCS, USDA, Edgerfield, S.C.

19. Johnson, M. L. A COMPARISON OF SNOWMELT HYDROGRAPHS. Eastern Snow Conf. Proc. 1963 pp. 149-168. 1963.

The timing and shape of runoff hydrographs were much more dependent upon channel characteristics, such as the stage-discharge relationship and drainage density for events occurring during the snowmelt season, when compared with those for other seasons.

When snow was present but not melting, the time lag from the end of intense rain to the inflection of the hydrograph was apparently dependent upon some exponential function of the permeability and depth of snow in the vicinity of the gaging station. Watersheds with the most snow responded slowest, regardless of watershed size or other characteristics, and also yielded proportionately less runoff (computed in watershed inches). Similarity to summer event hydrographs increased with the length of time that the rain continued, as the contributing area within a snow-covered watershed grew much more slowly. If the rain continued long enough, this similarity was very noticeable.

The hydrograph of an isolated snowmelt event was different from that of an isolated summer rain for two major reasons. The contributing area of a snow-covered watershed was initially small, and increased gradually to the limits of the watershed as the melt season progressed. Channel velocities were much greater during the snowmelt season due to consistently higher stages.

For a snowmelt event, air temperatures were to some extent synonymous with rainfall, and the rising pen trace of a thermograph was comparable to a rainfall mass curve.

The highest instantaneous rates of spring runoff occurred at the end of the snowmelt season, when conditions favored a rapid discharge to the channels. The maximum spring rate for the 4 years of record on the Sleepers River was caused by snowmelt combined with rainfall in 3 years, and snowmelt alone in 1 year. The rain of only 0.60 to 0.80 inch on April 7, 1962, combined with snowmelt to set a new record for the instantaneous rate of discharge from watershed W-5.

20. Stein, M. PROBLEMS AND PROGRAMS IN WATER POLLUTION. *Natural Resources J.* 2(3): 388-415. 1962.

A report on the problems and programs in water pollution in the various States of the United States was given.

In the 17 Western states, it was estimated that 92 percent of the water used is for irrigation and 3 percent is used by industry. In the 31 Eastern states, it was estimated that 81 percent of the water is used by industry and 3 percent for irrigation.

Objectives of a water policy for the individual states and the Nation are generally agreed to be: (1) The equitable apportionment of water among often conflicting demands; (2) the improvement of water quality; and (3) the stabilization of water flows and water supply.

While the maintenance of water quality is intertwined with the water quantity, in the past, those interested in allocation of available waters have too often ignored quality aspects--whether natural or man-made pollution. Water quality management must become an increasingly important part of water resource development if we are to have maximum multiplicity of uses. Effective water quality management encompasses development of comprehensive water resource programs on drainage basins, adequate treatment of municipal and industrial wastes, control of natural pollution, and provision of minimum stream flows during critical periods to preserve water quality where reasonable remedial and preventive devices are not sufficient to protect water quality. Moreover, water quality management will assure maximum re-use of waters flowing from headwaters to the sea. Economic saline water conversion to potable water will still pose expensive transportation problems for delivery inland from a sea level base.

FRESH WATER-USE FOR MAJOR PURPOSES
1900-1980
(in billions of gallons a day)

Year	Domestic & Municipal	Industrial	Irrigation	Total
1900.....	3.0	15.0	22.2	40.2
1920.....	6.0	27.2	58.4	91.6
1950.....	14.1	84.0	104.6	202.7
1960.....	22.0	159.0	141.0	322.9
1970.....	27.0	218.3	165.9	411.2
1980.....	37.2	394.2	165.7	597.1

Public Health Serv., U.S. Health, Ed., and Welfare, Washington, D.C., 20250

21. McGuinness, C. L. WATER FOR THE UNITED STATES: AN ANALYSIS OF THE REPORT OF THE SENATE SELECT COMMITTEE ON NATIONAL WATER RESOURCES. *Natural Resources J.* 2(2): 187-225. 1962.

From the report of the Senate Select Committee and from other available information, the writer draws the following conclusions:

1. Water use is going up, but it is not going up as rapidly as predicted in the Committee's report. Water demands have increased more rapidly than the population. Nevertheless, it cannot be assumed that per capita use of water will continue to

increase indefinitely. Rising costs of obtaining water, and the fact that the supply is fixed, will combine to force greater economy and efficiency in water use. The factors of increasing costs and increasing water shortages that the Committee assumes will lead to increased efficiency in irrigation cannot help but operate in the other principal withdrawal uses, municipal supply, and industrial use.

2. Ground water will be developed on an increasing scale to meet water demands where surface supplies are inadequate or of unsuitable quality or temperature. Ground water reservoirs will be used to a much greater extent for storage of surplus surface water. Ground water development costs money, in many cases enough to make conservation and re-use of existing supplies, or development of ground water on a limited scale, more attractive economically than the initially contemplated development.
3. Research and investigation are the prime need. To obtain the scientific and technical knowledge required to do the job will call for greatly increased efforts in education and research.
4. If time and money are made available to acquire the basic education, do the research, make the correct choices among alternative proposals, and design and construct the projects, we can meet our water needs for some decades to come by use of principles and techniques that are already known or can be seen to be emerging. But our population and water demands will continue to increase indefinitely. Eventually, the needs will be such that our existing fresh-water supply will not be able to meet them. It is then that fundamental technical breakthroughs will be necessary to enable conversion and distribution of saline water.
5. The key to the whole situation is public education and support. There are two principal goals: (1) Public willingness to meet the increasing costs of supplying tomorrow's water; and (2) public adjustment to the increasingly centralized control of water developments that will be essential to rational water management.

U.S. Geol. Survey, Dept. Int., Washington, D.C., 20250

22. Soil and Water Conservation Research Division. SOIL AND WATER CONSERVATION RESEARCH IN THE PACIFIC NORTHWEST. U.S. Dept. Agr., Agr. Res. Misc. P. 923, 31 pp. 1963.

Soil and water conservation research in the Pacific Northwest covers a wide range of problems. Major emphasis is devoted to three general areas of research.

On semiarid sagebrush-rangeland watersheds, research emphasizes the hydrology. Detailed studies are conducted to determine both the characteristics of precipitation and the ultimate disposition of it--runoff, evaporation, transpiration, or ground water supplies. Similar studies are conducted on sediment--its source areas, transport overland and in channels, and deposition in ponds, streams, or elsewhere. These studies are used to develop useful mathematical relationships between various watershed properties and water supply and sediment production phenomena.

On nonirrigated grainlands, studies emphasize tillage, cropping practices, and fertility requirements. The results provide information leading to recommendations for controlling runoff and erosion and for making maximum use of available moisture supplies.

On irrigated lands, engineering and soil management studies are aimed toward: (1) Maximum efficiency in use of water and labor; (2) elimination of drainage and salinity or other adverse soil problems; and (3) determining the best management practices on major irrigated soils of the region. Again, much of the effort is concerned with developing criteria, instrumentation, and equipment to improve the design of both surface and sprinkler

irrigation systems. Other specialized studies include the infiltration and moisture storage properties of soils, the chemistry of organic matter and plant nutrient elements in soils, and the microbiologic properties of soils.

A few examples of recent soil and water conservation research were given.

Photographs.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

23. Myers, L. E. THE CONSERVATION AND BENEFICIAL USE OF WATER. 7th Ann. N. Mex. Conf. Proc. 15 pp. 1962.

The author states that an impartial evaluation of the evidence indicates that the United States, as a nation, will not suffer any catastrophic shortages of water. Estimates predicting such shortages have been wrong in the following ways:

1. These estimates have assumed that our presently luxurious use of water will continue or be increased. This assumption will certainly be wrong if serious water shortages develop. Although little effort has been directed toward increasing water use efficiency by municipalities, agriculture, and industry, much greater efficiency can be achieved through the application of existing knowledge.
2. These estimates have made no allowance for research progress in the fields of water supply development and management. Research and development now under way are gradually revolutionizing these fields. The principles and techniques of sonics, nuclear physics, physical chemistry, electronics, surface chemistry, plant physiology, micrometeorology, hydrodynamics, analogs, and high speed computers are being skillfully applied to solve problems as complex as anything encountered in space technology. Radically new materials and machines are being developed by industry to help solve our construction and maintenance problems. This work will not only increase the efficiency in use of existing water supplies but will permit us to develop new sources of supply.
3. A major source of water supply which has received too little attention is the precipitation which is now lost to nonbeneficial evaporation and transpiration. We can and will capture part of the estimated 3,000 billion gallons per day lost to evaporation by means of vegetation management and water harvesting. How much we capture will depend upon the seriousness of our need for additional water.

U.S. Water Conserv. Lab., SWCRD, ARS, USDA, Tempe, Ariz., 85281

24. Rowe, P. B. STREAMFLOW INCREASES AFTER REMOVING WOODLAND-RIPARIAN VEGETATION FROM A SOUTHERN CALIFORNIA WATERSHED. J. Forestry 61: 365-370. 1963.

A test of applied watershed management on the San Dimas Experimental Forest in southern California showed that streamflow yields could be appreciably increased. This was accomplished by clearing the deep-rooted woodland-riparian vegetation from selected canyon bottom reaches of Monroe Canyon. The increases in flow were especially important because they occurred primarily in summer and in the initial period of soil wetting during succeeding rainy seasons, when streamflow was lowest and water most needed.

During the one rainy season of heavy precipitation and continuously wet soils, the removal of the woodland-riparian vegetation had no appreciable effect on streamflow, peak discharge, or erosion rates. However, during wetting periods and during the one rainy season of light precipitation, streamflow yields, particularly during storms, were considerably increased.

Streamflow was inadequate to produce sediment movement in either the treated or control watersheds during these wetting periods. Removal of the tree-bush cover shading the stream course resulted in an increase in the algae content of the late spring and summer flows but had no other detectable effect on water quality.

The removal of the canyon bottom vegetation should be limited to carefully selected areas where conditions of climate, vegetation, soil, and water capable of yielding the desired increases are present.

Agr. Expt. Sta., Col. Agr., U. Ariz., Tucson, Ariz.

25. Wallis, J. R. LOGGING FOR WATER QUALITY IN NORTHERN CALIFORNIA. U.S. Forest Serv. Res. Note PSW-N23, 7 pp. 1963.

Land managers have developed these important rules for logging while preserving water quality: (1) Plan landings, roads, and skid trails so that they are not in the creekbeds and washes; (2) install adequate cross-drainage on all temporary roads and skid trails before moving to the next logging area; (3) remove temporary fills and drainage structures in water channels before leaving a logged area; (4) keep damaging traffic off unsurfaced roads that are soft; (5) repair and clean out all drainage ditches, dips, and culverts at least every fall; (6) compact big fills during road construction; (7) keep road fills and logging debris out of creeks; (8) keep bulldozers off steep slopes; (9) never construct upside-down fills (surface soils and slash underneath and rock on top); (10) see that all permanent roads have adequate drainage for surface and sub-surface water; and (11) use logging systems that minimize soil disturbance and road construction.

Many other variables besides logging methods and procedures influence the amount of sediment produced by a watershed. This thought can be expressed in mathematical terms by using the following equation:

$$E = f(M, T, V, L, G, U \dots)$$

E represents watershed erosion and is regarded as being a function of (f) meteorology (M), terrain (T), vegetation (V), land use and condition (L), susceptibility of soil material to gullyling and sheet erosion (G), and slope stability (U).

Soil erodibility indexes which correlate with measured differences in the susceptibility to erosion were developed. One such index--surface-aggregation ratio--was related to nine rock types commonly found in northwestern California. From the resulting index numbers, one can get an idea of the relative erodibility, or susceptibility to removal by running water, of the surface layer of soils developed from these various rock classes:

Rock type	Surface-aggregation ratio
Quartz diorite	132.4
Granodiorite	112.2
Cenozoic non-marine sediments	80.7
Schist	76.5
Diorite	71.4
Miscellaneous metamorphics	66.9
Basalt and Gabbro	57.1
Pre-Cenozoic marine sediments	51.7
Peridotite and Serpentinite	42.9

A soil developed upon a Siskiyou quartz diorite will, on the average, be 3.1 times more susceptible to sheet and rill erosion than one developed from serpentinite. When logging on such an area, one should be at least 3.1 times more diligent in applying the rules of "logging to preserve water quality."

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

26. Anderson, H. W. MANAGING CALIFORNIA'S SNOW ZONE LANDS FOR WATER. U.S. Forest Serv. Res. Paper PSW-6, 28 pp. 1963.

The hydrology of California's snow zone as it affects management for improved water yield was summarized. Broad sources of water yield, variability, and distribution were briefly reviewed. The effects of forests on the processes of snow accumulation and melt and soil moisture were assessed, and the effects of both theoretical evaluations and practical tests were brought together to indicate the effects of forest management alternatives on water yield.

Snow accumulation and total water yield can be increased by cutting forests. Interception and transpiration losses can be reduced without corresponding increases in evaporation from the snow and soil. Water yield can be delayed by cutting forests in patterns designed to slow snowmelt--retaining the shade of trees and minimizing back radiation of trees to the snowpack. Both streamflow and sedimentation have increased after commercial timber harvesting.

Clearing brushland in converting to forest will increase water yield during the conversion period by reducing interception and transpiration losses. The pattern of the new forest can be designed and managed to give delayed water yield as compared to yield from natural brushlands.

Specific suggestions for management were given in the appendix.

Pacific Southwest Expt. Sta., FS, USDA, Berkeley, Calif.

Geology

SEE ALSO 13, 186.

27. Garde, R. J., and Raju, K. G. R. REGIME CRITERIA FOR ALLUVIAL STREAMS. J. Hydraul. Div., ASCE 89 (HY 6): 153-164. Nov. 1963.

Several criteria were proposed, prior to 1963, to predict the nature of the bed and water surfaces of an alluvial stream under different conditions. Most of these criteria have been based mainly on flume data and used the shear stress as the chief parameter. This investigation revealed that these criteria do not predict the regimes of flow accurately enough for natural streams, as compared with those in flumes. Hence, instead of using the shear stress, a new criterion, using the individual values of hydraulic radius and slope, was presented. It was based on all the available data for flumes and natural streams. This criterion can be used for prediction regimes, in problems involving resistance to flow, as well as sediment transport.

U. Roorkee, Roorkee, India.

28. Raudkivi, A. J. STUDY OF SEDIMENT RIPPLE FORMATION. *J. Hydraul. Div., ASCE* 89 (HY 6): 15-33. Nov. 1963.

Laboratory results were used to show the variation of the bed friction factor with the formation of ripples and dunes under flowing water. The flow pattern in the lee of a ripple was compared with the wake at an abrupt expansion. For the latter, the flow pattern and results of turbulence measurements were shown in graphical form. Velocity, pressure, and shear stress measurements on a fixed ripple form were examined. An explanation was proposed for the mechanism of the formation of the regular ripple pattern. It was reasoned that the increased agitation and sediment entrainment where the interface, between the main flow and the wake, meets the boundary was responsible for the upstream sloping face of the ripple. The regular pattern will persist only as long as the wake was dissipated before it reached the next ripple crest. The ripple height was determined when the surface drag over the ripple crest was on the point of exceeding the value it had for the same flow over the flat sand bed.

Civ. Engin., U. Auckland, Auckland, New Zealand.

29. Blocker, W., and Bower, D. FILTER FOR SAMPLING SEDIMENT IN SMALL STREAMS. *J. Soil and Water Conserv.* 18: 222. 1963.

A filtering device was developed to collect sediment from water routed through a Coshocton wheel sampler on small-gaged watersheds. It is nearly 100 percent efficient and greatly facilitates the separation of sediment from runoff samples.

The filter is a circular piece of half-inch polyethylene foam held in place 3 inches below the rim of a number 5 galvanized tub.

The apparatus has performed satisfactorily on three small forested watersheds (1.28 to 1.63 acres in size) in Arkansas during the past 18 months. These are gauged at 3-foot H flumes; about 1 percent of the flow is diverted for sediment measurement by the Coshocton sampler.

No measureable sediment was found in water that has passed the filter. In tests with water containing known amounts of sediment, recovery was above 98 percent. With a 1.5-foot head of water, filtering capacity exceeded 6 gallons per minute, and there was no indication of clogging even in tests with highly turbid water.

Southern Forest Expt. Sta., FS, USDA, Hot Springs, Ark.

Engineering Design

SEE ALSO 28, 39, 127, 283.

30. Wu, I-P. DESIGN HYDROGRAPHS FOR SMALL WATERSHEDS IN INDIANA. *J. Hydraul. Div., ASCE* 89 (HY 6): 35-66. Nov. 1963.

The results of a hydrography study of small watersheds in Indiana were given to determine the shape of the hydrograph and the peak discharge for use in areas where no stream gaging station is available. A mathematical expression of the hydrograph containing certain parameters that could be correlated with identifiable and readily obtainable watershed characteristics provided the theoretical basis for establishing the synthetic hydrograph. Seventeen small watersheds in Indiana were analyzed to determine the relationship between two hydrograph parameters (time to peak and storage coefficient) and three watershed

characteristics (drainage area, length of main stream, and mean slope of main stream). A complete procedure for the design of the storm hydrograph for small, ungaged, watersheds was presented. The basic mathematical expression for the hydrograph was considered appropriate for general application.

Hydr. Data Sect., Ind. Flood Control and Water Resources Comm., Indianapolis, Ind.

31. Day, R. H. SIMPLE METHODS OF ESTIMATING CERTAIN NONLINEAR FUNCTIONS WITH EMPHASIS ON AGRICULTURAL DATA. U.S. Dept. Agr. Econ. Res. Serv. Agr. Hbk. 256, 28 pp. 1963.

Two elementary methods for fitting three different nonlinear functions to empirical data by means of simple linear regression were given. Iterative least square methods, which have been developed for estimating parameters of nonlinear functions, sometimes lead to certain difficulties in application. The much simpler methods described are useful tools for application. The relative merits of this approach versus the nonlinear iterative approach were briefly described.

The Spillman, Gompertz, and Pearl-Reed (logistic) functions were considered. The two methods presented for the Pearl-Reed function are already well known and are given first. The analogous methods derived for the Spillman and the closely related Gompertz curves were also given.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

32. Tschinkel, H. M. SHORT-TERM FLUCTUATION IN STREAMFLOW AS RELATED TO EVAPORATION AND TRANSPIRATION. J. Geophysical Res. 68: 6459-6469. 1963.

A method was developed to relate fluctuations in streamflow during long dry periods to evaporation from a pan. The mechanism of the fluctuations was explained by deriving water-balance equations for the riparian zone. With this method, it was possible to compute evapo-transpiration losses from the watershed during the dry season by measuring the difference between the actual streamflow and a "potential" streamflow depletion curve which represents streamflow in the hypothetical situation of absolutely no evaporation.

Dept. Forestry, Inter-American Inst. Agr. Sci. of OAS, Turrialba, Costa Rica.

33. Brakensiek, D. L. ESTIMATING COEFFICIENTS FOR STORAGE FLOOD ROUTING. J. Geophysical Res. 68: 6471-6474. 1963.

Storage flood routing is a method for predicting flood wave propagation in a stream. It is based primarily on the equation of continuity. Flow at a section is assumed to be a single-valued function of the flow area. Additional assumptions are used to develop a linear relationship between reach storage and reach inflow and outflow. The relationship defines two coefficients which correspond to the X and K of the Muskingum formulation for reach storage. Several estimating procedures were developed as a consequence of the derived relationships.

SWCRD, ARS, USDA, Beltsville, Md., 20705

34. Jarocki, W. HYDROLOGIC AND HYDRAULIC COMPUTATIONS OF CULVERTS AND SMALL BRIDGES. Off. Tech. Serv. OTS 60-21508, 160 pp. \$1.50. 1963.

A translated reprint of the book: "Hydrologic and Hydraulic Computations of Culverts and Small Bridges" published by Wydawnictwa Komunikacyjne, Warszawa, Poland, in 1953 was given.

For sale by Off. Tech. Service, U.S. Dept. Com., Washington, D.C. 20250

35. Simon, A. L. TRAVEL TIME OF WAVES IN BACKWATERS. J. Hydraul. Div., ASCE 89 (HY 6): 1-13. Nov. 1963.

Time of travel of elementary waves in prismatic channels with gradually varied flow was expressed by two parametric equations. The first equation gives the travel time over a reach. The second equation, which is analogous to Bakhmeteff's backwater function, gives the appropriate flow parameters of the reach. Parameters are the actual and normal Froude numbers. The simultaneous solution of the two equations furnishes the initial conditions for flood routing computations using the method of characteristics.

W. Va. Inst. Tech., Montgomery, W. Va.

36. Rumer, R. R., Jr., and Harleman, D. R. F. INTRUDED SALT-WATER WEDGE IN POROUS MEDIA. J. Hydraul. Div., ASCE 89 (HY 6): 193-220. Nov. 1963.

A laboratory model of a two-dimensional confined aquifer containing an isotropic, homogeneous, porous medium was used to investigate the gravitational convection and dispersion of salt water. An equation for the rate of movement of the intruding wedge toe was presented and experimentally verified for the case of zero net fresh ground water flow to the ocean. The earlier theoretical work of Henry in defining the equilibrium position of the intruded wedge was experimentally confirmed. The extent of the zone of dispersion at the salt-fresh interface due to the steady fresh water flow to the ocean was treated analytically, and reasonable agreement was found experimentally. The additional interfacial mixing due to tidal effects was shown to be governed by a longitudinal and a lateral coefficient of dispersion that are functions of the pore system geometry of the medium and the tidally-induced seepage velocities.

State U. N. Y. at Buffalo, Buffalo, N.Y.

37. Walton, W. C., and Prickett, T. A. HYDROGEOLOGIC ELECTRIC ANALOG COMPUTERS. J. Hydraul. Div., ASCE 89 (HY 6): 67-91. Nov. 1963.

Electric analog computers are versatile and simple equipment that allow ground water development schemes to be rapidly and accurately tested and allow the relative merits of alternate choices of development to be appraised. The electric analog computer consists of an analog model and excitation-response apparatus, i.e., waveform generator, pulse generator, and oscilloscope. The analog model is a regular array of resistors and capacitors whose values vary in accordance with the irregular physical dimensions and properties of nonhomogeneous aquifers.

The behavior of the electrical network was described by an equation that has the same form as the finite-difference equation for nonsteady state three-dimensional flow of ground water. Electrical and hydraulic units were connected by four scale factors. Excitation-response equipment force electrical energy in the proper time phase into the analog model and measure energy levels within the energy-dissipative resistor-capacitor network. Close agreement between analog computer and exact analytical solutions for three selected idealized aquifer situations was noted.

Ill. State Water Survey, Urbana, Ill.

38. Buras, N. CONJUNCTIVE OPERATION OF DAMS AND AQUIFERS. *J. Hydraul. Div.*, ASCE 89 (HY 6): 111-131. Nov. 1963.

The conjunctive use of a surface reservoir and a ground water aquifer was analyzed from the point of view of optimal operation. A mathematical model was established considering the system to be operated for N consecutive years. The method of dynamic programming was used in developing an optimal operating rule. A computer program was developed for the solution of the algorithm by means of the IBM 7090 digital computer. An optimal policy was obtained as a steady state solution, when the operating rule remained constant, irrespective of how many stages remained in the operation of the system. The computer program was tested for several combinations of input data, and an optimal policy was established for each combination. An illustrative example was included.

Technion, Israel Inst. Tech., Haifa, Israel.

Snow Surveys

39. Bergen, J. D. VAPOR TRANSPORT AS ESTIMATED FROM HEAT FLOW IN A ROCKY MOUNTAIN SNOWPACK. *Internat'l. Assoc. Sci. Hydrol.* 61:62-64. 1963.

An approximate model of energy transport in a dry snowpack was used to estimate the flux of water vapor within and from a natural snow cover in the Colorado Rocky Mountains from continuous measurements of the vertical temperature profile for 3 days preceding the spring thaw. Results indicated were as follows; (1) An average evaporation loss of about 0.3 gm./cm.²/day during this period; and (2) substantial water losses from the lowest strata of the snow cover.

The variation of water losses with temperature gradient was consistent with a free convection regime within the snow cover.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

Ground Water Recharge

40. DeWiest, R. H. M. REPLENISHMENT OF AQUIFERS INTERSECTED BY STREAMS. *J. Hydraul. Div.*, ASCE 89 (HY 6): 165-191. Nov. 1963.

The interrelation between surface water and ground water was studied for certain aquifers that are intersected by streams and subjected to water withdrawal by trenches or wells. The presence of relatively thin clayey lenses in these aquifers creates flow

conditions similar to those of leaky aquifers. In Part I, the estimated yield of a proposed ground water recharge project in the vicinity of Princeton, N.J., was numerically evaluated. A mathematical model was derived from idealized field conditions, and the flow equations were solved by means of Green's functions. In Part II, the mathematical techniques involving the use of Green's functions were extended to solve the problem of the flow to a group of wells in leaky aquifers with various boundary conditions.

Princeton U., Princeton, N.J.

WATER MANAGEMENT

Irrigation

SEE ALSO 4, 12, 15, 17, 143, 186, 187, 188, 189, 243, 277.

41. Jensen, M. E., and Haise, H. R. ESTIMATING EVAPOTRANSPIRATION FROM SOLAR RADIATION. *J. Irrig. and Drain. Div., ASCE* 89 (IR 4): 15-41. Dec. 1963.

Measured evapotranspiration (consumptive use) data from irrigated areas in western United States were collected, re-evaluated, and combined with estimates of solar radiation. Approximately 1,000 measurements for individual sampling periods for various crops were useable. The results provide mean numerical values to use in a dimensionless energy balance equation for predicting evapotranspiration.

Nitrogen Lab., SWCRD, ARS, USDA, P.O. Box 758, Fort Collins, Colo., 80522

42. Unger, J. L. THE MATHEMATICAL TREATMENT OF GRID-SURVEY DATA FOR LAND LEVELLING. *Netherlands J. Agr. Sci.* 11: 264-293. 1963.

The accuracy of the following three methods of calculating the volumes of earth movement for land levelling on account of grid-point data was investigated: Summation; four-point, and stereometric.

Two sources of errors appear to be responsible for the inaccuracies caused by the application of the summation method: (1) A systematic error in grid squares, where cut changes to fill; and (2) a statistical inaccuracy when evaluating the volumes of earth movement in grid squares traversed by the boundaries of the plot to be levelled.

The four-point method was subject to a similar deficiency mentioned under 1, though to a much lesser degree. The stereometric method appears to be free from both deficiencies. In grid squares with all corners either in cut or in fill and not traversed by the plot's boundaries, each calculation method gave the same results.

When the deficiency mentioned under 2 was eliminated, all three calculation methods gave the same earth-work balance for a plot that needed levelling.

The stereometric calculation was too complicated for practical application, but was found to be practicable to correct the summation method.

When the number of grid squares, where cut changes to fill, was comparatively small, results identical to those of the four-point method were obtained more quickly by applying a correction to the summation method than by applying the four-point method as such.

The various calculations with the aid of corrections were demonstrated.

A tentative comparison was made between calculated and true volumes. The stereometric calculation appears to give the closest approximation.

Interntl. Land Develop. Consultants Ltd., Arnhem, Netherlands.

43. Norton, J. S. DESIGN OF MINIMUM GALLONAGE SPRINKLER SYSTEMS FOR CRANBERRY BOGS. Mass. Expt. Sta. B. 532, 20 pp. 1962.

Since the first commercial production of cranberries around 1820, facilities for irrigating and protecting cranberries from frost gradually increased until in 1956 about 80 percent of the acreage had at least some water protection facilities. The principal means of irrigation and frost protection has been by flooding.

The first sprinkler irrigation system was installed on a 2-acre bog in 1931. Most of the present systems are of 2-inch pipe or larger with capacities ranging up to 1 inch of water per hour.

The low gallonage sprinkler system described was a sprinkler irrigation system having an application rate of less than 1/8-inch of water an hour.

Low gallonage sprinkler systems can often be used on bogs where irrigation or frost protection by flooding is impossible. As restrictions are applied to the use of water reserves it may eventually develop that low gallonage sprinklers will become the only legal means of applying water to cranberry bogs.

The sprinkler system can provide instant protection when the temperature falls to the danger point. One-tenth inch of water an hour will provide adequate frost protection for cranberry bogs and even 1/15-inch an hour has maintained a difference of 14 degrees between protected and unprotected vines.

When frost protection is required during the harvest season it is often possible to continue the harvest on the afternoon following the night of the frost where a sprinkler system was used. This is not possible where flooding is the means of protection.

The low gallonage sprinkler systems which use 3/4-inch to 1/4-inch polyethylene pipe for lateral lines can be provided for about \$500 per acre. This is considerably less than the conventional systems using metal pipe of 2-inch or larger size.

Low gallonage sprinkler systems may be used successfully for applying most spray materials and finely ground or soluble fertilizers.

Where sprinkler systems are used for frost protection, the thermometer that is used to govern the time of starting the system should be located on the bog with the bulb at vine level, in an area that is protected from the effect of air currents.

By judicious and careful use of a sprinkler system, coupled with adequate drainage of the bog, it should be possible to improve a root system that has been forced to the surface by previously poor drainage. This is very difficult if not impossible when flooding or ditch irrigation is used.

Expt. Sta., Col. Agr., U. Mass., Amherst, Mass.

44. Murphy, F. W., Sr. AUTOMATION'S ROLE IN IRRIGATION PUMPING. Irrig. Engin. and Maintenance 13(7): 12-13, 25. 1963.

A comprehensive basic discussion was given on what automation devices are available for irrigation and how they work on unattended engines.

Frank W. Murphy Manuf., Inc., Tulsa, Okla.

45. Tovey, R. A PORTABLE IRRIGATION SPRINKLER EVALUATION DEVICE. *Agr. Engin.* 44: 672-674. 1963.

A portable sprinkler evaluation device used for field evaluation of soil intake rate, sprinkler application rate, lateral spacing, and design of sprinkler systems was described and illustrated. The sprinkler head operates inside a shield; measurements are made with a jet of water penetrating the shield opening.

Condensation-Complete report 50 cents from *Agr. Soc. Agr. Engin.*, 420 Main Street N. W., St. Joseph, Mich., 49085

46. Robinson, A. R., Lauritzen, C. W., Muckel, D. C., and Phelan, J. T. DISTRIBUTION, CONTROL, AND MEASUREMENT OF IRRIGATION WATER ON THE FARM. U.S. Dept. Agr., Agr. Res. Serv. Misc. P. 926, 27 pp. 1963.

An irrigation system should be designed to provide correct distribution, control, and measurement of the irrigation water.

Several types of structures used to divert, convey, control, or measure irrigation water were described, and their functions were discussed.

ARS, USDA, Inform. Div., FCB, Hyattsville, Md., 20781

47. Ballinger, W. E., Hunter, A. H., Correll, F. E., and Cummings, G. A. INTERRELATIONSHIPS OF IRRIGATION, NITROGEN FERTILIZATION AND PRUNING OF REDHAVEN AND ELBERTA PEACHES IN THE SANDHILLS OF NORTH CAROLINA. *Proc. Amer. Soc. Hort. Sci.* 83: 248-258. 1963.

The effects of 3 rates of N application, 3 levels of pruning severity, and supplemental irrigation versus no irrigation, were studied on Redhaven and Elberta peaches planted at the Sandhills Peach Experiment Station near Jackson Springs, N.C., in 1953.

Harvests were made at the firm-ripe stage 3 times weekly during the 4 seasons 1956-59. Records were made of numbers, size and color of fruit, annual trunk area increase, length of terminal shoots, and weight of wood removed during pruning.

Overall effects of irrigation were not significant even though strong trends were apparent. Interactions with variety, N rate, and pruning indicated that the Redhaven variety responded to irrigation more than did Elberta. Droughts usually occurred during Redhaven ripening. Rainfall in July, prior to Elberta ripening, was relatively heavy thus eliminating the need for additional irrigation during the Elberta ripening season. Irrigated Redhaven trees produced: (1) A larger number of harvested fruit in the greater than 2 inch size-class than those not irrigated; this effect became less apparent as the trees were more heavily pruned. (2) A greater amount of harvested fruit on both a numbers and pounds basis than those not irrigated; this effect became more significant with each succeeding harvest season. And (3) a smaller number of harvested fruit in the small, less than 2 inch class than did non-irrigated trees when the N application rate was increased from N_1 to N_2 ; a further increase in N rate to N_3 negated this response.

Responses of peach trees to irrigation appeared to be influenced by season, pruning practices, N application rates, and the varieties involved.

N. C. Expt. Sta., Raleigh, N.C.

48. Middleton, J. E. IRRIGATION NEEDS OF HOPS. Wash. Agr. Expt. Sta., Sta. C. 417, 7 pp. 1963.

Two season's study on established hops and one season's study of first year hops showed that hops use nearly all of their water from the upper 4 feet of the soil. Essentially no water was used from below 6 feet. Hops used very little water early in the season and the use-rate continually increased until maturity. Peak use occurred during the first 2 weeks of August and use-rate then declined rapidly.

Water use-rate was much more dependent on amount of foliage of the growing hop than on changes in weather. Thus, irrigation cannot be accurately scheduled with present methods using measured evaporation.

Wash. Agr. Expt. Sta., Inst. Agr. Sta., Wash. State U., Pullman, Wash.

49. Musick, J. T., Grimes, D. W., and Herron, G. M. WATER MANAGEMENT, CONSUMPTIVE USE, AND NITROGEN FERTILIZATION OF IRRIGATED WINTER WHEAT IN WESTERN KANSAS. U.S. Dept. Agr., Agr. Res. Serv. Prod. Res. Rpt. 75, 37 pp. 1963.

Management effects on efficient use of irrigation water and applied nitrogen for production of hard red winter wheat were given. The authors concluded that:

1. Fall irrigation to 6 feet in 4 years with normal to above-normal precipitation produced near maximum grain yields of 44 to 51 bushels per acre. One additional irrigation at boot stage in the dry spring of 1954 increased yields 12.9 bushels per acre. Additional irrigations did not affect yields significantly.
2. Applied nitrogen increased grain yields up to 6 bushels per acre for rates of 30 to 60 pounds per acre. High rates decreased yields and test weights. Residual nitrogen on the higher treatments increased yields significantly in 1 of 2 years.
3. Optimum seasonal water use was 22 to 24 inches; maximum use, 24 to 26 inches; and most efficient use for grain production, 20 to 22 inches. The peak rate of use was 0.35 inch per day, which occurred from flowering-to-milk stage of grain. Fruiting stage of development was most critical for moisture stress.
4. Efficiency of water use decreased under severe moisture stress, excessive irrigation, and low nitrogen availability. Maximum efficiency of water use was about 2.4 bushels per acre-inch.
5. Considerable moisture stress did not occur until soil moisture closely approached the permanent wilting percentage. Wheat entered the spring growing season with an extensive rooting system. This rooting system, which exceeded 6 feet in depth, was able to explore thoroughly the soil for moisture extraction.
6. High moisture and nitrogen availability during spring tillering-through-jointing stages caused rank straw growth. The desirable low straw/grain ratios (pounds of straw produced per pound of grain) occurred on the lower irrigation and nitrogen treatments.
7. Higher soil moisture and nitrogen availability decreased resistance to lodging. Lodging was slight on the optimum irrigation and nitrogen treatments as compared to severe lodging in some years under excessive irrigation and high nitrogen fertilization.
8. Irrigated wheat consistently produced high test weights. In 1954, spring irrigations were required to prevent shriveling from hot, drying winds.

9. Grain protein quantity decreased with increasing soil moisture availability, but protein increased with increased nitrogen availability. Increasing moisture availability increased protein quality, loaf volume per increment of protein, which somewhat compensated for decreased quantity. Grain with satisfactory quality was produced when excessive irrigation was avoided. Nitrogen increased protein quantity from 0.013 to 0.022 percent per pound of applied N for rates up to 60 pounds per acre.
10. Monthly coefficients for the Blaney-Criddle consumptive-use formula were 0.57 in October, 0.32 to 0.36 in late fall and winter dormancy, 0.40 in March, 0.81 in April, 1.08 in May, and 1.00 in June. Seasonal coefficient was 0.71.
11. Efficient use of a limited water supply may be realized by spreading the water over a large acreage. Fall irrigation during September through November will provide beneficial use of available water when it is not needed for irrigating other crops.

ARS, USDA, Inform. Div. Room 645A, FCB, Hyattsville, Md., 20781

50. Enyi, B. A. C. THE INFLUENCE OF VARYING PHOSPHORUS AND WATER SUPPLY ON THE GROWTH AND YIELD OF A SWAMP RICE VARIETY (ORYZA SATIVA L.) J. Agr. Sci. 61(2): 227-231. 1963.

The effect of 'wet' and 'dry' soil conditions, and the three different levels of phosphorus were determined for growth and yield for a swamp rice variety BG 79. The author concluded that:

1. 'Wet' soil plants had greater tiller and leaf number, and were also taller than 'dry' soil plants.
2. The straw and grain dry weight, and grain weight as percentage of straw weight, were greater in 'wet' soil plants than in 'dry' soil ones.
3. Wet soil hastened the time of ear emergence.
4. Increasing the phosphate supply, on the whole, tended to increase the tiller and leaf number, weight of straw and grain, and hastened the time of ear emergence.
5. Under 'wet' soil conditions, high phosphate application was not necessary.
6. The yield of grain at high phosphate level of plants grown on 'dry' soil was significantly lower than the yield from those grown on 'wet' soil with low phosphate application. This suggested that under 'dry' soil conditions availability of nitrogen, as well as of phosphorus, was a limiting factor.

Col. Agr., V. Nigeria, Nsukka, Nigeria.

51. Lawrence, T. SEED YIELD OF RUSSIAN WILD RYEGRASS GROWN ON AN IRRIGATED CLAY SOIL IN SOUTHWESTERN SASKATCHEWAN. J. Range Mangt. 16(6): 311-312. 1963.

A study was conducted during the period 1955-61 on part of a seed production field of Russian wild ryegrass which was seeded in rows 3 feet apart in 1953 and produced its first seed crop in 1955.

Ammonium nitrate (33.5-0-0) and ammonium phosphate-sulphate (16-20-0), were applied at rates supplying 0, 25, and 50 pounds of N per acre. Fertilizers were applied in April and August in 1955 and thereafter in August only.

The soil at the site of the test was a Sceptre heavy c. Irrigation water was applied in May and after seed harvest each year. Approximately 3 to 4 inches of water were applied per irrigation. The author concluded that:

1. Fertilizer applications resulted in increased seed yields of Russian wild ryegrass.
2. There was little value in applying fertilizer until after the first seed crop.
3. There was a tendency for seed yields to decrease with increasing age of the stand. After four seed crops, the yields were so low that it was impractical to maintain the stand.
4. Of the two fertilizers tested, 33.5-0-0 was the most economical to use.

Expt. Farm, Res. Br., Canada Dept. Agr., Swift Current, Saskatchewan, Canada

52. Hutchins, W. A. BACKGROUND AND MODERN DEVELOPMENTS IN WATER LAW IN THE UNITED STATES. Natural Resources J. 2(3): 416-444. 1962.

A review of the background and modern developments in water law was given for the United States.

ERS, USDA, Washington, D.C., 20250

53. Jones, D. S. DESIRABLE FEATURES OF WATER RIGHTS LAW. J. Irrig. and Drain. Div., ASCE 89 (IR 4): 1-6. Dec. 1963.

Experience in administrating state water laws has shown that laws that are based on the appropriation doctrine and that do not recognize any claimed riparian rights are more desirable from the viewpoint of an administrator. The law should declare that all waters of the state are public and are subject to appropriation and use as provided by law. One central state agency should have authority to grant water rights, to police the streams, to enforce said rights, and to cancel rights when the appropriator ceases to use water for the purpose for which the appropriation was granted. The decisions of the administrator should be appealable directly to the Supreme Court. Preferential uses of water should be spelled out in the law, and the use of water for a purpose with a high preference should be permitted if a prior appropriator for an inferior purpose is justly compensated for any interference resulting therefrom. A water rights law should apply equally to all of those who desire to use the public waters, including agencies of the United States.

Nebr. Dept. Water Resources, Lincoln, Nebr.

Drainage

SEE ALSO 9, 13, 42, 186, 190.

54. Saveson, I. L. AN EFFICIENT DRAINAGE SYSTEM FOR SUGARCANE. U.S. Dept. Agr., Agr. Res. Serv. ARS 41-72, 12 pp. 1963.

The sugarcane section of Louisiana, with a high-intensity, average annual rainfall of 60 inches, requires adequate surface drainage. The present drainage system, over a century old was designed for the use of hand labor and mules for sugarcane production and drainage maintenance.

The drainage system with precision land leveling that was developed for cotton production was tested to see if it could be adapted for sugarcane production. The results of the experiment was given. It was concluded that the cotton-type drainage system combined with land forming could be used for sugarcane production on medium-textured soils. The chief benefits derived from this system were:

1. There were no quarter drains to maintain.
2. Field drains were accessible for mowing and maintaining with farm tractors and small pull graders.
3. The precision-formed fields were free of depressions, thus providing better surface drainage and permitting more efficient equipment operation, especially during wet harvests.
4. Four to seven percent more land originally in ditches was available for sugarcane production.
5. Field drains were crossed by farm machines with little difficulty in tilling and harvesting.
6. Yields of sugarcane were increased 2 tons or more per acre.
7. Annual maintenance costs were \$5.22 per acre less than with the conventional drainage system.

SWCRD ARS, USDA, Beltsville, Md., 20705

55. Boa, W. DEVELOPMENT OF A MACHINE FOR LAYING PLASTIC DRAINS. *J. Agr. Engin. Res.* 8: 221-230. 1963.

A machine was developed in which a flat ribbon of plastic foil is fed down a hollow subsoiler blade and formed into a pipe at drain level. The pipe-forming die is so designed that it causes tabs and notches along the edges of the foil to be interlocked forming a strong seam. Water enters the pipe through the seam and through slits punched around the bottom half of the pipe.

A forward raked digging tine was adopted as this has a lower draught than a vertical one and an accurate fitting bed of firmed soil was prepared for the pipe by the action of a shaped share and a trailed shoe. Lightweight porous fill can be laid over the pipe to increase the discharge of mole channels.

The machine has provision for accurate depth control and is made as a trailed unit to allow haulage by winch or track-laying tractor. The development of the machine and the first field trials were described.

National Inst. Agr. Engin., Wrest Park, Silsoe, Bedford, England.

56. Fouss, J. L. PLASTIC TUBES FOR SUBSURFACE DRAINAGE. 4th Ann. Natl. Agr. Plastics Conf. Proc. 4: 137-142. 1963.

Experimental field installations have been made in several areas of the U.S. to evaluate various types of plastic mole liners under different soil and climatic conditions. The zipper-type liner appears the most promising. The structural stability of the zippered plastic mole liner depends to a large extent upon the moisture condition of the soil at the time of installation and the inherent stability of the soil surrounding the liner. The soil must have sufficient moisture to prevent excessive fracturing of the soil profile during the installation. If the soil is too dry it cannot be "firmed" properly above the drain by the slit closure

device on the installation tool. This recompaction of the soil surrounding the plastic liner is important so that it will have sufficient load-bearing strength to prevent outward movement of the liner walls.

This type of subsurface drainage is still undergoing extensive research and development. Further changes and improvements in the equipment, grade-control devices, and plastics are being considered to fully study the principles involved. Probably the most important application of plastic-lined moles will be in heavy clay soils, since their lower cost would permit closer drain spacings than considered economical with present methods. They may also be used for leaching saline soils. Because these drains are small, they are intended only as laterals, not mains.

There are other advantages for this drainage method besides low-cost and high-speed installation. Plastic-lined mole drains can be installed in many fields without disrupting normal farming operations. Their use eliminates the conventional wide trench, spoil pile, and longterm backfill settlement. These features may also make them useful in nonagricultural drainage projects for highways, airports, parks, golf courses, and building areas.

SWCRD, ARS, USDA, Columbus, Ohio, 43210

57. Snodgrass, G. F. DESIGNING A PUMPING SYSTEM FOR FLOOD CONTROL IN THE EVERGLADES. *Agr. Engin.* 44: 616-617, 619. 1963.

A report on a successful high-volume, low-shifting pumping plant for flood control to protect winter vegetable crops in the Everglades of Florida was given.

For sale for 50 cents by ASAE, 420 Main St., St. Josephs, Mich.

Storage and Conveyance

SEE ALSO 18, 38, 70, 72, 252, 255, 256, 257, 258, 297, 281, 283.

58. Myers, L. E. WATER HARVESTING BY CATCHMENTS. *Seventh Ann. Ariz. Watershed Symposium*, Phoenix, Ariz. Sept. 18, 1963. 12 pp. 1963.

A report on the water harvesting by catchments at the U.S. Water Conservation Laboratory at Tempe, Ariz., was given. The use of catchment aprons along with seepage reduction and evaporation reduction were described.

The author concluded that water harvesting will be widely used for the development of stock water supplies just as soon as reasonably priced construction materials and methods are developed. Stock tank locations will no longer be restricted to intermittent stream channels. They will be placed where they are needed, built only as big as needed, and there will be many more of them. They will not reduce streamflow for downstream water users. Water supplies will be more dependable, for catchments will collect water from light showers that never produce stream channel flow. Distribution of cattle and utilization of rangelands will be greatly improved. All this will begin to happen as soon as we can build durable catchments, seal earth tanks, and reduce evaporation losses effectively at low cost.

U.S. Water Conserv. Lab., SWCRD, ARS, USDA, Tempe, Ariz., 85281

59. Rollins, M. B., Dylla, A. S., and Myles, G. A. EXPERIMENTAL BENTONITE SEALING. Nev. Agr. Expt. Sta. B. 229, 11 pp. 1963.

The sealing power of bentonite was tested in permeable sands at Fallon, Nev. The results of the first year's tests were given.

The reservoirs were located on porous soils containing a large percentage of sand. Water was supplied to the experimental reservoirs from a nearby canal. Staff gages were used to measure the loss of water from each reservoir. The depth of water lost per unit of time was used to calculate the seepage rate of each reservoir. An evaporation pan provided data for correcting evaporation losses. Nine reservoirs were treated with bentonite and three reservoirs were used as controls.

Bentonite was applied by three methods: (1) Mixing dry with sand; (2) dispersion in water; and (3) dispersion in water followed by harrowing the bottom and walls of the reservoir. Each reservoir was treated with about 1 or 2 pounds of bentonite per square foot of surface.

Treating reservoirs located in permeable fine sand with bentonite saved up to 99 percent of the water previously lost through seepage.

Drying caused the bentonite to lose some of its seal. After drying the reservoirs for 1 month and then reponding, the seals were 75 to 80 percent effective.

One bentonite seal could be installed at about the annual cost of 4 inches of concrete amortized over 30 years at 6 percent interest. Therefore, bentonite appears favorable as a competitive sealer, since one application of bentonite may last several years.

Simple and effective methods of forming the bentonite seals must be further developed before this sealing method can be fully utilized to conserve sparse irrigation water or to reduce damage by high water tables.

Agr. Expt. Sta., Max C. Fleischman Col. Agr., U. Nev., Reno, Nev.

60. Timmons, F. L., Bruns, V. F., Lee, W. O., Yeo, R. R., Hodgson, J. M., Weldon, L. W., and Comes, R. D. STUDIES ON THE CONTROL OF COMMON CATTAIL IN DRAINAGE CHANNELS AND DITCHES. U.S. Dept. Agr., Agr. Res. Serv. Tech. B. 1286, 51 pp. 1963.

Common cattail is an economically important weed in drainage and irrigation canals, farm ponds, reservoirs, marshes, and the margins of lakes. Life history and control studies were made in the Pacific Northwest.

The achene-like fruit of common cattail germinated and the seedling developed either submersed in water or on wet soil. A single seedling grown in a culture tank produced as many as 98 nonflowering shoots 2 to 48 inches tall and 104 crown buds in the first season. The shoots of older cattail developed slowly from crown buds in early spring, elongated rapidly in late spring, and reached the flowering stage by early summer. Pistillate spikes matured by late summer. The spikes contained an average of more than 200,000 seeds. New crown buds began to develop in midsummer after pollination and produced vegetative shoots during the remainder of the growing season. Numerous new crown buds developed at the end of the growing season.

The level of carbohydrates in cattail roots and rhizomes was relatively high in early spring but decreased rapidly during vigorous growth in late spring. The seasonal low was reached when the shoots began to flower in early July. Thereafter, the trend was rapidly upward throughout the growing season, except for a brief period in late August coincident with the rapid development of new shoots.

Severance of shoots below the water surface two or three times in one growing season during preheading or early heading stages reduced the stand of cattail 95 to 99 percent.

Many herbicidal formulations were tested alone or in combination for control of common cattail. The most effective and economical herbicides at all locations were esters of 2,4-D in oil-water emulsions (4 to 8 lbs./A.), amitrole (8 to 12 lbs./A.), and the sodium salt of dalapon (20 lbs./A.).

Limited tests showed no advantage in mixing amitrole and sodium salt of dalapon or either of these herbicides with 2,4-D.

Erbon was effective on cattail in Montana. The optimum rate of erbon was 40 pounds per acre.

Ammonium and sodium salts of TCA and various soil sterilant herbicides were only partially effective at several locations.

Repeated applications of aromatic oils showed some promise of controlling cattail in Utah.

No single chemical application or mechanical treatment eliminated common cattail. However, one application of amitrol, erbon, or sodium salt of dalapon, two applications of 2,4-D-diesel oil-water emulsion, two cuttings below the water level, or three sprayings with aromatic oil per season greatly reduced the stand the first year and frequently eliminated or nearly eliminated cattail in 2 or 3 years. The cattail not standing in water was more persistent than cattail standing in water, except when treated with aromatic oil. Repeated spraying with this oil was equally effective in either case.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

61. Austin, W. G. L. CONTROL OF AQUATIC WEEDS. Outlook Agr. 4(1): 35-43. 1963.

Recommended control methods for aquatic weeds were given for irrigation and drainage canals, ponds, and lakes. The author concluded that chemicals are now available that will control most of the important species of aquatic weeds. All these compounds, however, have limitations: the perfect aquatic herbicide has yet to be discovered. Chemicals will play an increasingly important part in aquatic weed control. Progress will inevitably be slow because of: (1) The sheer difficulty of evaluating weed-killers in an aquatic environment; (2) the need for careful investigation of possible side effects; and (3) the new problems which the use of chemicals may create in some cases.

When weeds are cut, control is usually only temporary, regrowth commences very quickly and the original balance of species is more or less maintained.

Some chemicals offer the chance of long-lasting control, or even complete eradication, of the original weed growth, but it is unlikely that water or ditchbanks thus cleared will remain permanently free of vegetation. The spread of resistant species or re-invasion by fresh species, possibly more difficult to control, may be one of the biggest problems associated with the use of aquatic herbicides and, in the absence of a panacea, a range of chemicals must be available to deal with the different situations that may arise.

Jealott's Hill Res. Sta., Brocknell, Berkshire, England

62. Mayhew, J. K., and Runkel, S. T. THE CONTROL OF NUISANCE AQUATIC VEGETATION WITH BLACK POLYETHYLENE PLASTIC. Iowa Acad. Sci. Proc. 69: 302-309. 1962.

Large sheets of black polyethylene plastic were used to control nuisance aquatic vegetation in small ponds and lakes. The plastic was floated over vegetation beds and left

unattended for a predetermined number of days. Adequate control of all species of Potomageton was achieved in 10 to 18 days. Ceratophyllum demersum was eliminated in the control plots in 18 to 28 days. Control was unsuccessful for Chara vulgaris and Saggattarius latifolia. All control plots were revegetated with filamentous algae within 30 days after the covering was removed.

State Conserv. Comm., Chariton, Iowa.

BASIC SOIL SCIENCE

Soil Physics

SEE ALSO 10, 11, 32, 49, 105, 117, 118, 121, 123, 124, 125, 127, 130, 137, 139, 140, 141, 142, 143, 144, 145, 146, 154, 169, 170, 194, 199, 202, 272.

63. Boekel, P. SOIL STRUCTURE AND PLANT GROWTH. *Netherlands J. Agr. Sci.* 11: 120-127. 1963.

The influence of the structure of the top soil on growth and yield of several crops was studied, especially on clay soils. Soil structure was characterized by visual estimation and by measurements of pore space and air content at pF 2.

For a period of 30 years, an average yield increase of 25 percent was obtained by improving the structure of a heavy clay soil. The highest yield was obtained when the visual structure index was at least $5\frac{1}{2}$, corresponding to an air content at pF 2 of at least 15 vol. percent. In 1 year, early summer was rather dry and a more compact soil structure (visual structure index 4) gave the better plant growth.

On a silt soil, a favorable influence of good soil structure on yield was found. Depending on crop and weather, a pore space of 48-50. vol. percent, corresponding to an air content at pF 2 of 14-17 vol. percent, was required to obtain the highest yield. In 1 year, an unfavorable influence of a higher pore space on the yield was obtained due to a rapid depletion of soil nitrogen in the early stages of growth.

There were indications that the most favorable air content at pF 2 in sand soils (used here as an index for soil structure) was about 20-25 vol. percent. At higher air contents, the yield decreased through water deficiency. At lower air contents at pF 2, the mechanical resistance of the sand soil seemed to be limiting root growth.

The relation observed between visually estimated aggregate size and porosity on one side and visual estimation of soil structure on the other gave the possibility to convert the results for clayey soils to data more suitable for soil tillage purposes. On a heavy clay soil, a visual estimation of $5\frac{1}{2}$ --6 corresponds to a structure characterized by rather dense clods, with mean diameter 0.5-1 cm. or to a structure characterized by porous aggregates of 5-10 cm.

Inst. Soil Fertility., Groningen, The Netherlands.

64. Taylor, H. M., and Burnett, E. SOME EFFECTS OF COMPACTED SOIL PANS ON PLANT GROWTH IN THE SOUTHERN GREAT PLAINS. *J. Soil and Water Conserv.* 18: 235-236. 1963.

Soil pans, hardpans, plowpans, pressure pans, and plow soles--all are terms applied to localized breakdowns in soil structure that occur frequently throughout the Southern

Great Plains. Usually formed immediately below the normal depth of plowing, these pans are found on soils of nearly all textures; but they occur most frequently on fine sandy loam, loamy fine sand, or sandy clay loam soils.

During the last few years, concerted efforts have been made to determine the actual effects of these pans on plant growth. A review of some of the results of these research efforts was given.

Southwestern Great Plains Field Sta., SWCRD, ARS, USDA, Bushland, Tex., 79012

65. Roderick, G. L., Demirel, T., and Davidson, D. T. USE OF PHOSPHORIC ACID AND FURFURYL ALCOHOL FOR SOIL STABILIZATION. *Iowa Acad. Sci. Proc.* 69: 370-379. 1962.

Results of an investigation of the effects of phosphoric acid and furfuryl alcohol on the resistance and strengths of a clayey soil and of a sandy soil were given. Greater water resistance and higher strengths were obtained with both soils by using the admixtures. For the sandy soil, a certain optimum amount of phosphoric acid gave the maximum strengths for all furfuryl alcohol contents. The stabilization mechanism for the clayey soil was thought to be a combination of the formation of phosphoric gels and of a resin product of a furfuryl alcohol polymerization reaction. The mechanism for the sandy soil is the formation of the polymerization resin product. The following conclusions were made:

1. The use of phosphoric acid and furfuryl alcohol with a clayey soil resulted in higher immersed and unimmersed strengths than those obtained by the use of phosphoric acid alone.
2. The use of phosphoric acid and furfuryl alcohol with a clay soil gave more water resistance after air drying than did the use of phosphoric acid alone.
3. The use of phosphoric acid and furfuryl alcohol with a sandy soil, when cured by air drying, provided cohesion which resulted in attainment of immersed and unimmersed unconfined compressive strengths.
4. For the sandy soil, a certain optimum phosphoric acid content gave the maximum immersed and unimmersed strengths for all amounts of furfuryl alcohol.

Iowa Engin. Expt. Sta., Iowa State U., Ames, Iowa.

66. Gabrillides, S. T., and Alexiadis, C. A. SOME MEASUREMENTS WITH A SIMPLE SOIL PENETROMETER. *J. Agr. Engin. Res.* 8: 262-266. 1963.

A simple penetrometer was used in order to obtain field data of some soil characteristics; two types of probes, for light and heavy soils, are available and the spring can be adjusted according to soil resistance. Results showed that, in certain cases, the penetrometer was a useful device in giving a quantitative comparison of the differences between some soil characteristics.

Agr. Engin. Dept., Agr. Sch. Aristotelian U., Thessaloniki, Greece.

67. Koenigs, F. F. R. THE PUDDLING OF CLAY SOILS. *Netherlands J. Agr. Sci.* 11: 145-155. 1963.

Some basic ideas were discussed on the relation between soil micro-structure and soil-water. The moisture content of a clay soil is the result of an equilibrium between the

swelling pressure and the soil-suction plus Madelung attraction. However, frictional forces, caused by organic matter bonds and by edge-surface attraction, tend to fix any given arrangement. When the primary particles were moved in relation to each other, the true equilibrium between swelling pressure and suction was obtained.

The influence of mechanical treatments on soil micro-structure at increasing moisture contents was explained in a qualitative way. With increasing moisture content, the cohesion within the aggregates falls off rapidly, but the friction between the aggregates tends to increase. Depending on the force applied, the maximum friction will develop at moisture contents above or below the moisture equivalent. As this frictional force also determined the drawbarpull, its effect on the force exercised on the aggregates was cumulative. Near the moisture equivalent, the intra-aggregate cohesion is weak and therefore an infinite number of shear planes may develop (plasticity). At moisture contents near the saturation point, the friction falls off again and with it the degree of puddling caused per unit of mechanical action.

The properties of puddled soils were: (1) The air filled pore volume largely reduced; (2) the permeability lowered; (3) the suction raised, (4) the resistance to raindrops lowered; and (5) the deformability increased. The regeneration of puddled soils is only possible by drying, either through evapotranspiration or by freezing. As puddling will very often occur during harvesting operations (sugarbeet) freezing will be the most important process: it has the special advantage of dividing the soil into aggregates of favorable dimension.

Lab. Soils and Fert., Agr. State U., Wageningen, The Netherlands.

68. van Bavel, C. H. M., Fritschen, L. F., and Reginato, R. J. SURFACE ENERGY BALANCE IN ARID LANDS AGRICULTURE 1960-61. U.S. Dept. Agr., Agr. Res. Serv. Prod. Res. Rpt. 76, 46 pp. 1963.

Instrumentation and an appropriate experimental site were completed at the U.S. Water Conservation Laboratory for the detailed study of the surface energy balance in an arid climate.

Outstanding features of the installation are a precision weighing lysimeter system for the measurement of evaporative flux, greatly improved and accurate net radiometry, and a completely automatic and trouble-free data handling system with a total capacity of 46 channels, including lysimeter weight, windspeed and direction, heat flux, radiation, temperature, and humidity.

Four major experiments were carried out during the late spring of 1961 on the following experimental sites: (1) A small wetted surface; (2) a small ponded surface; (3) a large ponded area; and (4) a large wetted area. The soil was bare in all cases. In each experiment, pertinent data were collected every 15 minutes for several days under near-perfect and identical weather conditions, which were typified by clear skies, light winds, and low humidity.

A preliminary, gross analysis of the data was presented in addition to selected examples of more detailed information. The tentative conclusions were:

1. When the entire observation area (about 100 X 100 m.) was uniformly treated, the evaporative flux from a shallow layer of water and from a wet, bare soil surface showed little difference despite greater net radiative flux over the shallow layer of water. In neither case was heat extracted from the air on a daily basis, but the opposite took place, particularly over shallow water.
2. Over an isolated (1 X 1 m.) ponded surface considerable downward flux of sensible heat was found over a 24-hour period and also over an isolated wet surface (1 X 1 m.)

The progressive drying of the soil surface affected the energy balance profoundly by increasing the albedo and surface temperature, and by decreasing the transport of soil moisture to the surface. In consequence, net radiation decreased, evaporation decreased, and heat flux from the surface into the air increased. No great influence on soil heat flux was found.

3. Even though net radiation and soil heat flux varied smoothly with time of day, evaporative flux was not regular, particularly during the middle and latter part of the day. Also, sensible heat flux into the air varied in sign and magnitude, seemingly dependent upon surface conditions and wind character.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

69. Yamamoto, T. SOIL MOISTURE CONSTANTS AND PHYSICAL PROPERTIES OF SELECTED SOILS IN HAWAII. U.S. Forest Serv. Res. Paper PSW-P2, 10 pp. 1963.

Soils from 34 sites representing 10 great soil groups common in Hawaii were analyzed for soil moisture constants and physical properties. Data representing known land use were grouped into four categories: Forest; cultivated area; pasture; and idle grassland. The author concluded that:

1. Most surface soils in Hawaii were fine-textured and composed of aggregates of clay and colloidal particles. The forest soils had structures that favored infiltration and percolation of water.
2. Forest soils had the lowest average bulk density; and pasture and cultivated soils had higher bulk densities. Except for some of the ash soils of Hawaii, bulk density tended to decrease as rainfall increased.
3. Soils on the island of Hawaii had the highest plastic limits, the wet area soils of Kauai and Oahu had intermediate values, and the dry area soils on the three islands had lower values of plastic limit.
4. Pasture and forest soils had the highest average organic matter content.
5. The specific gravity of soil particles of all soils sampled averaged 2.86.
6. Average total pore volume was highest under forest cover.
7. The average volume of large pores was highest in the forest soils and lowest in the cultivated and idle grassland soils.
8. Average field capacity was about the same under each of the four land use categories.
9. Average available moisture was highest in the forest soils and lowest in the pasture soils.
10. The average wilting point of the soil was lowest under forest and highest under pasture.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

70. Michel, C. EVAPORATION CONTROL: A NEW TOOL FOR WATER MANAGEMENT. J. Soil and Water Conserv. 18: 223-229. 1963.

Once precipitation has been impounded, the next great challenge is to put it to effective use. Evaporation, because it is usually invisible, is seldom regarded as a serious drain on stored water. Yet, annual evaporation losses from impoundments in the 17 Western States exceed the usable water storage capacity of all impoundments in California.

Since water storage is increasing importance in water resources development, evaporation control merits greater attention as a means of supplying additional water to meet the nation's rapidly expanding water needs.

The author concluded that a process of evaporation control can be developed to increase available water supplies at a cost in line with the current price of fresh non-subsidized water, that is, within a range of \$0.10 to \$0.20 per thousand gallons at the point of use. The overwhelming percentage of water uses in the United States now and in the future involve cheap water. Should a lack of foresight compel dependence on high-priced water, the position of the United States in the world would be weakened.

There never will be a panacea for the water problem because there is no single water problem. Evaporation control as a tool is only as good and useful as the hands that guide it. Because the demand for water continues to grow rapidly, planning ahead for better water utilization is imperative. The wise conservationist should begin now to find out how evaporation control methods can be applied in his area to keep the water cheap, to keep it plentiful, and to save it for a rainless day.

Molecular Tech. Inc., 90 Broad St., New York, N.Y.

71. Stephens, J. C., and Stewart, E. H. A COMPARISON OF PROCEDURES FOR COMPUTING EVAPORATION AND EVAPOTRANSPIRATION. Internat'l. Union Geodesy Geophys. 13th Gen. Assembly Proc. 1962. 7: 123-133. 1963.

Comparison of correlation coefficients for measured versus computed monthly pan evaporation in South Florida over a 6-year period showed the Weather Bureau Method ranked highest and the Thornthwaite Method lowest of nine methods. In a similar comparison for 30 months of measured versus computed potential evapotranspiration from St. Augustinegrass, the Fractional Evaporation Equivalent Method ranked highest and the Thornthwaite Method again ranked lowest. Evapotranspiration was predicted with more accuracy than pan evaporation.

SWCRD, ARS, USDA, Athens, Ga., 30601

72. Abdalla, A. A., and Flocker, W. J. THE EFFECT OF HEXADECANOL ON WATER LOSS FROM SOIL AND PLANTS. Proc. Amer. Soc. Hort. Sci. 83: 849-854. 1963.

Some effects of varying rates and methods of application and the form in which hexadecanol was applied to a soil on the loss of water from a soil and some plants were evaluated. Consideration was given to the effect the material has on the saturated water conductivity of soil, the loss of water from excised plants, and yield of two crops.

High rates of application (600 lbs. or more per acre) of hexadecanol reduced evaporation from bare soils. Low rates (100 lbs. or less per acre) had no effect in reducing evaporation unless a continuous supply of water was available.

Applications of 600 lbs. or more per acre seriously reduced percolation of water into the soil.

Hexadecanol reduced the wilting rate of excised sweet corn and tomato plants. Rates of application of 100 lbs. or more per acre reduced growth, while application rates of 10 to 50 lbs. per acre enhanced growth of sweet corn and tomatoes.

Jr. Author, U., Calif., Davis, Calif.

73. van Bavel, C. H. M., Nixon, P. R., and Hauser, V. L. SOIL MOISTURE MEASUREMENT WITH THE NEUTRON METHOD. U.S. Dept. Agr., Agr. Res. Serv. ARS 41-70, 37 pp. 1963.

Many research locations have adopted the neutron method for the measurement of soil moisture content. This method has been used in irrigation, recharge, lysimeter, and water-shed-management studies on the consumptive use of water by plants. As a result, much additional experience with the method has accumulated and several questions regarding field procedure were answered. Still the method has not been perfected to the satisfaction of those concerned even though there have been many changes in the design of the equipment that is now available.

This revised report was made to bring the information on the neutron method up to date. Information to those contemplating adoption of this method and to those who already use it but wish to improve their present techniques was reported. Background information required for rational and successful use of the method was given. Sufficient information to enable the individual investigator to choose the procedure best suited to his particular needs was included.

SWCRD, ARS, USDA, Beltsville, Md., 20705

74. Winter, E. J. A VALVELESS SOIL MOISTURE DEFICIT INDICATOR. J. Agr. Engin. Res. 8: 252-255. 1963.

A valveless soil moisture deficit indicator was described in which the evaporating surface consists of a cylindrical jute wick arranged centrally within the receiving funnel and drawing its water supply from the rain receiver by capillarity. When necessary, a special mask can be used to reduce evaporation rate from the wick without affecting the rate at which it collects incident rainwater.

Under test, a group of instruments gave readings in close agreement, and the deficit they indicated was satisfactorily related to the cumulative soil moisture deficit estimated from meteorological records.

By attaching suitable sensor devices, the instrument could be used for automatic control of irrigation equipment or for providing remote warning of excessive runoff in catchment areas.

Natl. Veg. Res. Sta., Wellsbourne, Warwick, England

75. Miller, R. J., and Low, P. F. THRESHOLD GRADIENT FOR WATER FLOW IN CLAY SYSTEMS. Soil Sci. Soc. Amer. Proc. 27: 605-609. 1963.

The presence of a threshold gradient for water flow in clays was established. The threshold gradient is the hydraulic gradient below which no flow occurs. The threshold gradient decreased with decreasing clay concentration and increasing temperature. At gradients above the threshold gradient, the flow rate-gradient relationship was essentially linear, except at low gradients for the concentrated clay systems but curvilinear for the less-concentrated clay systems. These results were explained on the basis of a quasi-crystalline water structure which developed in the clay-water systems as a result of water-surface interaction.

N.C. State Col., Raleigh, N.C.

76. Biggar, J. W., and Nielsen, D. R. MISCELLY DISPLACEMENT: V. EXCHANGE PROCESSES. *Soil Sci. Soc. Amer. Proc.* 27: 623-627. 1963.

Miscible displacement experiments have shown that the physical processes associated with microscopic flow velocities should be included in any theory of exchange during flow through soils. Water contents and average-flow velocities were controlled in Oakley soil columns initially saturated with Ca ion. Without disturbing the water content and flow velocity, Ca acetate of 0.1N and 0.05N concentration was displaced by MgCl₂ solutions of similar concentration. The distribution of Mg²⁺ and Cl⁻ ion in the effluent was related to the volume passing through. Mg²⁺ ion appeared in the effluent well in advance of that predicted on the basis of exchange theory. Three mathematical models that include the exchange process were compared with the data to ascertain their usefulness in predicting positions and shapes of breakthrough curves. Although the theories were generally inadequate, they did serve to emphasize the important contribution of microscopic flow velocity and ionic diffusion to the mixing or dispersion of solutions in porous media and to exchange processes.

U. Calif., Davis, Calif.

77. Goodell, B. C. A REAPPRAISAL OF PRECIPITATION INTERCEPTION BY PLANTS AND ATTENDANT WATER LOSS. *J. Soil and Water Conserv.* 18: 231-234. 1963.

Recently published, laboratory-type studies have suggested that the vaporization of rain or snow intercepted by vegetation may result in a water loss from that site that is less real than apparent because of a compensating reduction in transpiration.

The magnitude of such compensation under field conditions was questioned in view of: (1) Transpiratory regulation by plants under the stress of limited water availability; (2) probability that the energy available for evapotranspiration from wet leaves is greater than from dry leaves; and (3) the possibility that under winter conditions in cold climates transpiration is limited more by the availability of water than of energy and that interception increases the quantity of water favorably exposed to the energy supply.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

78. Anderson, D. M., Linville, A., and Sposito, G. TEMPERATURE FLUCTUATIONS AT A WETTING FRONT: III. APPARENT ACTIVATION ENERGIES FOR WATER MOVEMENT IN THE LIQUID AND VAPOR PHASES. *Soil Sci. Soc. Amer. Proc.* 27: 610-613. 1963.

Mean flow rates for water movement in the liquid and vapor phases were measured at several temperatures in three representative porous media. Apparent activation energies, calculated by means of a form of the Arrhenius equation, were found to vary from 4.3 to 6.1 kcal. per mole. A comparison of these values with the magnitudes of the potential energy barriers encountered in several relevant phenomena led to a postulation of the rate-limiting processes for the two flow situations. The rate of advance of the liquid front was concluded to be limited partly by the viscosity of thin films of water at the leading edges of menisci and partly by the rate of extension of air-water interface. The rate of vapor movement was concluded to be determined primarily by the evaporation rate at the wetting front.

Ariz. Agr. Expt. Sta., Tuscon, Ariz.

Soil Chemistry and Mineralogy

SEE ALSO 90, 101, 102, 103, 106, 109, 110, 111, 117, 118, 121, 123, 133, 137, 138, 151, 155, 157, 159, 161, 162, 163, 164, 165, 166, 167, 168, 177, 182, 183, 184, 185, 187, 188, 190, 199, 203, 256, 289, 290.

79. De Haan, F. A. M., and Bolt, G. H. DETERMINATION OF ANION ADSORPTION BY CLAYS. *Soil Sci. Soc. Amer. Proc.* 27: 636-640. 1963.

In interpreting the observed interaction between anions and clays the following two aspects should be recognized: (1) The negative adsorption of anions by negatively charged sites; and (2) the positive adsorption on other sites (probably the edges).

A generalized equation was developed describing the contribution of the negative adsorption. With regard to experimental methods, the need of the use of radionuclides to detect small quantities of positive adsorption was discussed. Data obtained support the applicability of the derived equation to montmorillonite systems and indicate that a small amount of positive adsorption of SO_4^{2-} was present.

State Agr. U., Wageningen, The Netherlands.

80. Le Roux, F. H., and Coleman, N. T. ION SORPTION BY SOIL SEPARATES AND EX-CHANGE EQUILIBRIA INVOLVING SODIUM, POTASSIUM, AND RUBIDIUM. *Soil Sci. Soc. Amer. Proc.* 27: 619-623. 1963.

Sodium-potassium exchange reactions were studied with four California soils, utilizing chromatographic and equilibrium procedures. Apparent exchange constants varied with ion saturation and indicated a larger affinity for potassium as its equivalent fraction on exchange sites decreased. This was especially true for soils containing biotite-hydrobiotite-vermiculite in the coarse fractions. Clay and silt-size materials from such a soil were packed into columns, and the sorption-desorption behavior of rubidium was measured using the radioisotope Rb-86.

Irreversible sorption of rubidium with corresponding reductions in cation-exchange capacity was large for silt, intermediate for coarse clay, and negligible for fine clay. Sodium-rubidium exchange isotherms obtained for various size fractions both before and after a portion of the exchange-capacity was "blocked" with Rb or K indicated a quite specific sorption of Rb on certain sites, with "normal" ion-exchange behavior for the remainder of the CEC.

X-ray diffraction studies suggested specific sorption of K and Rb by vermiculite and hydrobiotite, irrespective of the Na/K or Na/Rb ratio in saturating solutions. However, even when sites with specific affinity for Rb or K were eliminated, there was significant variation in the apparent exchange constants obtained for different soils. For soil containing vermiculite in the coarse fractions, the specific sorption of radiorubidium may be conveniently determined guide to potassium fertilizer needs.

U. Calif. Citrus Res. Cent., Riverside, Calif.

81. Munns, D. N., Jacobson, L., and Johnson, C. M. UPTAKE AND DISTRIBUTION OF MANGANESE IN OAT PLANTS. II. A KINETIC MODEL. *Plant and Soil* 19: 193-204. 1963.

Oat roots contain definable fraction of replaceable Mn, normally about 30 percent of the total. Manganese enters this form rapidly. It can be extracted with electrolyte solutions.

The nonreplaceable Mn in the roots consists of at least two further fractions which differ in lability of movement. The manganese enters the more labile fraction rapidly, and while there, it can exchange with substrate ions, although more slowly than the replaceable Mn does, or it can move readily to the shoot. Manganese enters the nonlabile fraction slowly, and, once there, it turns over and exchanges sluggishly, and is translocated at negligible rate so long as Mn is still supplied in the substrate. The difference in rate at which these two nonreplaceable fractions become labelled with Mn-54 permits their experimental separation and measurement.

U. Calif., Berkeley, Calif.

82. Mehta, K. M., Puntamkar, S. S., and Kalamkar, V. G. STUDY OF UPTAKE OF NUTRIENTS BY WHEAT AS INFLUENCED BY NITROGEN AND PHOSPHORUS FERTILIZATION. *Soil Sci. and Plant Nutr.* 9: 195-200. 1963.

Influence of the application of N and P alone and in combination on concentrations of N and P and their uptake by wheat plants was studied at three stages of growth under pot culture conditions. Application of fertilizers increased the dry weight and N and P uptake at flowering stage. N and P concentrations were maximum at tillering stage. At maturity, the concentration of N and P in roots was higher than in shoots. Maximum phosphorus concentration occurred by P application alone as compared to other treatments. As the fertilized plants at flowering stage attained maximum dry weight and N and P uptake, the grain production appeared more dependent on transfer of nutrients from shoots to grain than upon removal of nutrients from the soil.

Agr. Chem. Section., Udaipur, Rajasthan, India .

83. Brown, J. C. INTERACTIONS INVOLVING NUTRIENT ELEMENTS. *Ann. Rev. Plant Physiol.* 14: 93-106. 1963.

The subject of the interactions involving nutrient elements was reviewed for the soil chemist, the plant physiologist, and the plant biochemist. Selected papers were taken to illustrate what might be considered the most productive outlets for future research in the role of an element in plant growth and its interactions involving other nutrient elements.

Mineral Nutr. Lab., SWCRD, ARS, USDA, Beltsville, Md., 20705

84. Olsen, S. R., and Watanabe, F. S. DIFFUSION OF PHOSPHORUS AS RELATED TO SOIL TEXTURE AND PLANT UPTAKE. *Soil Sci. Soc. Amer. Proc.* 27: 648-653. 1963.

Differences in the diffusion coefficients of phosphorus (P) between sandy and clay soils were applied to explain variations in rates of P uptake by corn seedlings from equal initial concentrations of P in the soil solution. The relation between labile P of the solid phase and P concentration in solution or the phosphate capacity, also varied with the clay content of the soil. An equation uptake of P by plant roots to the diffusion coefficient and the phosphate capacity showed that the rate of uptake was proportional to $\sqrt{b D_p}$ where D_p is the diffusion coefficient and b is the slope of the line relating labile P to concentration of P in solution or the phosphate capacity, when other factors are constant. The equation predicts that the rate of uptake of P will be one-third as much from the sandy soil as from the clay

soil at equal concentrations of P in the soil solution. Actual measurement of the rate of P uptake by corn seedlings agreed closely with the predicted values from the equation for P concentrations < 0.2 p.p.m. As the clay content of three soils increased from 17 to 51 percent, the diffusion coefficient for P increased from 1.1×10^{-7} to 6.7×10^{-7} cm.² per sec. and the b value increased from 110 to 178.

SWCRD, ARS, USDA, Fort Collins, Colo., 80521

85. Forshey, C. G. THE EFFECT OF NITROGEN STATUS OF MCINTOSH APPLE TREES IN SAND CULTURE ON THE ABSORPTION OF MAGNESIUM FROM EPSOM SALTS SPRAYS. *Proc. Amer. Soc. Hort. Sci.* 83: 21-31. 1963.

Apple trees were grown in sand culture with 2 N and 3 Mg treatments in factorial combination. At the end of the growing season, the trees were separated into leaves, shoots, trunk, bark, fibrous roots, and large roots. Each fraction was dried, weighed, and analyzed for total N, Mg, K, Ca, and P.

Absorption of Mg from both Epsom salts sprays and soil applications was satisfactory in trees receiving the higher rate of N, but not in the low N trees. The increase in absorption of Mg associated with the higher rate of N were more than could be attributed to differences in growth. Absorption of K and Ca was similarly affected.

The distribution of Mg was markedly affected by N level. A greater part of the total Mg was found in the leaves and a lesser part in the permanent tissues of the high N trees than of the low N trees. This was also true of all other elements determined.

Hudson Valley Fruit Investigation Lab., Poughkeepsie, N.Y.

86. Forshey, C. G. A COMPARISON OF SOIL NITROGEN FERTILIZATION AND UREA SPRAYS AS SOURCES OF NITROGEN FOR APPLE TREES IN SAND CULTURE. *Proc. Amer. Soc. Hort. Sci.* 83: 32-45. 1963.

The response of apple trees to urea sprays was investigated in sand culture. The absorption, movement, and distribution of N in trees receiving all N in the form of urea sprays were compared with that of trees receiving N through the culture solution. In one study, equal amounts of N were added; in another, supply was regulated to provide equal absorption. The effect of urea sprays on the absorption and distribution of other elements was also studied.

About 2/3 of the N applied as foliar sprays was absorbed while essentially all that was added to the culture solution was taken up by the trees. There was appreciable movement of N from the leaves of the urea-sprayed trees to other tissues, but this amounted to little more than the N content of the leaves when the first spray was applied. Net movement was negligible and increasing the number of sprays, and the amount of N absorbed, did not increase movement.

In the trees sprayed with urea, leaf N levels did not accurately reflect the N status of the entire tree. This effect was most pronounced soon after the sprays were applied and was greatly modified with time, but remained serious enough to merit consideration in the interpretation of leaf analyses.

When the foliage N and soil N trees received equal amounts of N, absorption of other elements appeared to be adversely affected by the foliage N treatment. In this case, there was a difference in the amount of N absorbed as well as in the manner in which it was

applied. When the two treatments absorbed comparable amounts of N, absorption of other elements was also comparable.

N.Y. State Agr. Expt. Sta., Highland, N.Y.

87. Allison, F. E. LOSSES OF GASEOUS NITROGEN FROM SOILS BY CHEMICAL MECHANISMS INVOLVING NITROUS ACID AND NITRITES. *Soil Sci.* 96: 404-409. 1963.

The chief chemical mechanisms by which gaseous losses of nitrogen may occur from soils containing nitrous acid or nitrites were discussed. These were: (1) By chemical decomposition of nitrous acid; (2) by the Van Slyke reaction, which is defined sharply as the reaction between nitrous acid and α -amino acids only, with nitrogen gas as an end product; and (3) by the formation and decomposition of ammonium nitrite, which mechanism of nitrogen loss is shown to be distinctly different from the Van Slyke reaction. Present evidence indicates that the first of these channels of loss is only occasionally important and then in acid soils of low exchange capacity; the second is rarely, if ever, important in soils; and the third may be the major channel of loss apart from ammonia volatilization and biological denitrification.

SWCRD, ARS, USDA, Beltsville, Md., 20705

88. Skryabin, F. A. INFLUENCE OF MINERAL FERTILIZERS ON THE HUMIFICATION OF ALFALFA ROOTS AND MANURE IN SIEROZEMS (FROM GREENHOUSE EXPERIMENTS). *Soviet Soil Sci.* 12: 1396-1400. Dec. 1962.

Organic carbon losses from the soil are less on old plowed sierozems with a cotton crop and with application of mineral fertilizers than on old plowed sierozems with a cotton crop but without fertilizer.

Composting of soil deficient in organic matter, with nitrogen and phosphorus fertilizers without plants increased the organic carbon losses while the composting of soil which was rich in organic matter (alfalfa roots or manure) with the same fertilizers decreased carbon losses from soil enriched with organic matter.

Scripta Technica Inc., 1000 Vermont Ave. N.W., Washington, D.C., 20005

89. Bobritskaya, M. A. NITROGEN INTAKE IN SOIL FROM ATMOSPHERIC PRECIPITATION IN VARIOUS ZONES OF THE EUROPEAN USSR. *Soviet Soil Sci.* 12: 1363-1367. Dec. 1962.

The amount of the annual nitrogen intake in all soil-climatic zones of the European USSR was established as 3-4.5 kg./ha. (2.7 to 4.0 lb./A.) independent of the amount of annual precipitation, which indicates a more or less permanent fixed nitrogen content in the atmosphere.

Nitrogen entering the soil with atmospheric precipitation is mostly in the ammonium form. The number of oxide forms of nitrogen increases somewhat toward the south.

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Soil Biology

SEE ALSO 87, 88, 104, 119, 136, 138, 163, 165, 166, 167, 177, 185, 203, 290.

90. Cooper, G. S., and Smith, R. L. SEQUENCE OF PRODUCTS FORMED DURING DENITRIFICATION IN SOME DIVERSE WESTERN SOILS. *Soil Sci. Soc. Amer. Proc.* 27: 659-662. 1963.

The sequential products of anaerobic denitrification were determined on seven Western soils (four alkaline, two acid, and one neutral) by soil and gas analysis. The soils with 1 percent alfalfa and added KNO_3 were incubated at moistures slightly greater than field capacity and with an atmosphere of He. The soils and gases were periodically analyzed and balance sheets prepared. The sequence of $\text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{N}_2\text{O} \rightarrow \text{N}_2$ operated in all soils. The N_2O and N_2 were determined on a gas chromatograph. The rates of nitrogen interchanges and maximal amounts of nitrite, N_2O , and N_2 were determined.

It was postulated that the rate-limiting process for denitrification in acid soils was in the reduction of nitrate, while in alkaline soils it was the reduction of nitrite. The reduction of N_2O was rapid in all instances. The total time for complete reduction of 300 p.p.m. N as nitrate to N_2 at 30° C . varied only from 28 to 96 hours for the seven soils. Lowering the temperature to 25° or 20° C . influenced all rates for three alkaline soils and resulted in a twofold increase in denitrification time for the 10° C . drop. Decreases in initial concentration of added KNO_3 to 150, 75, and 37.5 p.p.m. did not change the overall rate of denitrification. There was however, a marked reduction in the maximal amounts of N_2O found in the gaseous atmosphere when the initial KNO_3 concentration was reduced.

Mount San Antonio Col., Walnut, Calif.

91. Nömmik, H., and Nilsson, K. FIXATION OF AMMONIA BY THE ORGANIC FRACTION OF THE SOIL. *Acta Agr. Scandinavia* 13: 371-390. 1963.

The extent to which the ammonia form of nitrogen was fixed by the organic matter of the soil was studied in the laboratory. Ammonium hydroxide, urea, and calcium cyanamide were used as sources of nitrogen. The added nitrogen not removed from the soil on prolonged leaching with HAc-CaAc_2 buffer solution (or 0.5 N HCl) was considered as fixed. The time of reaction varied from 1 to 23 days.

The ammonia-fixing capacity of the soils was intimately correlated with their organic carbon content. The organic soils fixed substantially more ammonia than the mineral soils. In relation to their carbon content, the low-humified natural peats fixed approximately twice as much ammonia as the cultivated mucks.

The ammonia fixation was accompanied by a simultaneous consumption of oxygen. A strong positive correlation existed between these two properties.

The capacity to fix ammonia was markedly influenced by the pH of the soil. The extent of fixation was strongly increased by increasing the pH of the soil during incubation. At pH levels above 10, the figures of net fixation were significantly affected by the simultaneous non-enzymatic deamination of the organic nitrogen compounds of the soil and by the dissolution of the organic matter. Erroneously low results for the absolute magnitude of ammonia fixation may thus be obtained. At pH levels below 7, only insignificant amounts of ammonia were fixed.

Nitrogen added as urea was fixed in a non-sterilized soil to about the same extent as ammonium hydroxide. At high concentration levels, the fixation from urea was, however,

considerably lower. When added as calcium cyanamide, more than twice as much nitrogen was fixed as on treatment with an equivalent amount of ammonium hydroxide.

Royal Col. Forestry, Stockholm, Sweden

92. Yevdokimova, T. I. TOXICITY OF SOME MOSSES AND LICHENS TO AZOTOBACTER IN KARELIAN SOILS. Soviet Soil Sci. 8: 852-855. Aug. 1962.

The soils studied in Karelia, Russia, exhibited a sharp difference in toxicity to Azotobacter. All the virgin forest soils regularly showed toxicosis, the most toxic of these being the primitive coarse-humus soils under moss-lichen vegetation. Removal of the cover of reindeer moss (Cladonia rangiferina) from the soil resulted 3 years later in an appreciable decline in the toxicity of this soil and in a sharp increase in the fungus population (Penicillium in particular).

Gradual replacement of the mosses and lichens with mixed grasses resulted in decreased toxicity of the virgin soils. Plowing and systematically cultivating them gradually reduced their toxicosis with respect to Azotobacter.

Since the lichens possess high antibiotic action against many groups of microorganisms, the toxicosis of primitive Karelian soils with respect to Azotobacter was believed to be largely due to the secretions of the lichens and mosses.

Scripta Technica Inc., 1000 Vermont Ave. N.W., Washington, D.C., 20005

93. Rovira, A. D. MICROBIAL INOCULATION OF PLANTS: I. ESTABLISHMENT OF FREE-LIVING NITROGEN-FIXING BACTERIA IN THE RHIZOSPHERE AND THEIR EFFECTS ON MAIZE, TOMATO, AND WHEAT. Plant and Soil 19(3): 304-314. 1963.

Seeds of maize, tomato, and wheat were inoculated with cultures of Azotobacter, Clostridium, and a nitrogen-fixing facultative Bacillus and grown in a nutrient-deficient sand and a highly fertile silt loam.

In sand, wheat showed a significant positive response to seed inoculation with Azotobacter and Clostridium but maize and tomato were unaffected by inoculation.

When inoculated seed was planted in Lima sil there were significant increases in the growth of maize, tomato, and wheat to treatment with Clostridium, inoculated maize and wheat responded to Azotobacter inoculation while only wheat responded to inoculation with the facultative Bacillus.

In pure-culture studies of the ability of these cultures to establish upon plant roots it was shown that Azotobacter did not colonize the roots of lucerne, maize, tomato, or wheat to any great extent. Bacillus and Clostridium were moderate colonizers of plant roots reaching from 1 to 20 percent the levels reached by Pseudomonas fluorescens on the same plants.

Cornell U., Ithaca, N.Y.

Soil-Plant-Animal-Relationships

SEE ALSO 93, 133, 147, 158, 166, 174, 175, 176, 179, 180, 181, 189, 202, 292.

94. Benson, N. R., Degman, E. S., Chmelir, I. C., and Chennault, W. SULFUR DEFICIENCY IN DECIDUOUS TREE FRUITS. Proc. Amer. Soc. Hort. Sci. 83: 55-62. 1963.

Pale yellow and unthrifty fruit trees were observed in the field. Good green color and healthy growth were restored by an application of a sulfate. Nutrient solution studies to

determine the S content of leaf tissue associated with deficiency symptoms, indicated that basal leaves were not useful for diagnosing S deficiency of apple and pear. However, immature tip leaves did show less than 100 p.p.m. sulfate S after symptoms appeared. Any peach leaves may be useful but the tip leaves appeared to be superior to the older mature leaves for diagnosing S deficiency. Here, also, 100 p.p.m. was associated with deficiency.

A survey was made of certain orchards where S deficiency was probable. Leaf samples were collected and records obtained of the S applications in the form of fertilizer and sprays. Samples of water used for irrigation were also collected. Sulfur deficiency never occurred where sulfate fertilizer was used. Sulfur deficiency rarely occurred when the S content of the irrigation water exceeded 0.7 p.p.m. Sulfur sprays usually provided sufficient S to prevent deficiency, but some pear orchards showed the deficiency even when dormant S sprays were applied.

Wash. State U., Tree Fruit Expt. Sta., Wenatchee, Washington.

95. Forshey, C. G. POTASSIUM-MAGNESIUM DEFICIENCY OF MCINTOSH APPLE TREES. Proc. Amer. Soc. Hort. Sci. 83: 12-20. 1963.

A fertilizer experiment was conducted in a low vigor McIntosh apple orchard with foliage levels of K and Mg below optimum, but with no visible symptoms of deficiency of either element. Differential K and Mg fertilization treatments were maintained for 5 years. Despite the absence of typical foliage deficiency symptoms, K fertilization increased tree growth, fruit size, and yield, and applications of Mg reduced pre-harvest fruit drop. Response to applications of K were more rapid and more pronounced than response to Mg treatments. Apparently the initial problem of low vigor was due to K deficiency, but expression of typical leaf symptoms was inhibited by the concurrent low level of Mg.

The inverse relationship between K and Mg did not become a problem where K was applied at a comparatively low rate and in combination with an effective Mg treatment. However, in one year in which K levels were relatively high and Mg levels were relatively low, increasing the rate of application of K or applying it alone or in combination with an ineffective Mg carrier did reduce leaf Mg.

Significant effects of rainfall, crop load, and N level on leaf K were revealed. These factors should be considered in the interpretation of leaf analyses.

Hudson Valley Fruit Investigations Lab., Poughkeepsie, N.Y.

96. Leggett, G. E., and Boawn, L. C. PHOSPHATE-INDUCED ZINC DEFICIENCY. 14th Ann. Fert. Conf. Pacific Northwest, Idaho Falls, Idaho, July 9-11, 1963 Proc. pp. 101-105, 108. 1963.

A review article on phosphate-induced zinc deficiency was given. The problem of phosphate-induced Zn deficiency appears to be associated with the physiological functions of Zn and P within the plant rather than the interaction of these elements in the soil. The solution of the problem likely will come through detailed studies of the specific biological functions of Zn and P and the possible linking of these two elements in some vital process within the plant.

SWCRD, ARS, USDA, Prosser, Wash., 99350

97. Johanson, F. D., and Walker, R. B. NUTRIENT DEFICIENCIES AND FOLIAR COM-
POSITION OF STRAWBERRIES. Proc. Amer. Soc. Hort. Sci. 83: 431-439. 1963.

Size, form, and coloration of leaves in the strawberry plant were altered in distinctive patterns by deficiencies of essential nutrient elements. The reduction in size was most apparent in leaves of plants deficient in N, S, B, and Fe.

The change in form of the leaves was most evident where B, Ca, or S was deficient.

Color changes in the leaves were distinctive, both as to the nature of the color and the pattern of occurrence. Blue pigmentation, first appearing in small surface veins, but soon encompassing the entire blade, was indicative of P-deficiency; flaming orange-red in older leaves, of N-deficiency; marginal reddening and scorch, of K-deficiency; interveinal purple banding, of Mg-deficiency; and development of interveinal chlorosis and purple stripping, of Mn-deficiency.

These several changes in size, shape, and color of leaves, along with seasonal variations, provide criteria that aid in diagnosing field nutrient disorders. They are indicative of the levels of nutrient elements contained in the leaves, for they apparently are not expressed until critical levels are reached. The levels of nutrients in the deficiency solutions were reflected in the levels absorbed into the foliage. Deficiencies of specific elements often caused deviations in the foliar content of one or more other essential elements.

Tables and color charts.

Wash. State U. Expt. Sta., Seattle, Wash.

98. Muth, O. H., and Allaway, W. H. THE RELATIONSHIP OF WHITE MUSCLE DISEASE
TO THE DISTRIBUTION OF NATURALLY OCCURRING SELENIUM. J. Amer. Vet.
Med. Assoc. 142(12): 1379-1384. 1963.

Areas where soils may be expected to contain, at least to some extent, Selenium (Se) derived from sedimentary rocks laid down during the formation of the Rocky Mountains are generally areas where incidence of white muscle disease (WMD) in livestock has been very low.

An extensive area where WMD occurs sporadically occurs around the Great Lakes, in the northern part of the Appalachian Plateau, and in New England. In this area, soil-forming materials are dominated by rocks of Mississippian and older geologic formations or from glacial and lacustrine materials derived from these older rocks.

White muscle disease is a serious problem in some of the areas of northwestern United States where geologically young volcanic rocks are the predominant source of soils.

Distribution of Se in soil parent materials may be an important factor in the geographic occurrence of WMD.

Oreg. State U., Corvallis, Oreg.

99. Page, A. L., Martin, J. P., and Ganje, T. J. FOLIAR ABSORPTION AND TRANS-
LOCATION OF POTASSIUM BY CITRUS. Proc. Amer. Soc. Hort. Sci. 82: 165-171.
1963.

The results of greenhouse and field studies have shown that the K content of citrus leaves can be increased markedly by using foliar applications of KNO_3 solutions, and that the foliar-absorbed K is readily translocated to new growth. The KNO_3 sprays had little, if any, effect upon the levels of Na, Ca, and Mg in the leaves.

U. Calif., Citrus Res. Cent. and Agr. Expt. Sta., Riverside, Calif.

100. Labanauskas, C. K., Jones, W. W., and Embleton, T. W. EFFECTS OF FOLIAR APPLICATIONS OF MANGANESE, ZINC, AND UREA ON YIELD AND FRUIT QUALITY OF VALENCIA ORANGES, AND NUTRIENT CONCENTRATIONS IN THE LEAVES, PEEL, AND JUICE. *Proc. Amer. Soc. Hort. Sci.* 82: 142-153. 1963.

The main effects and interactions of foliar sprays of Mn, Zn, and urea in factorial combinations were studied relative to: (1) Yield and fruit quality; (2) micronutrient and N concentrations in the leaves, correction of deficiency symptoms, and duration of response; and (3) micronutrient and N concentrations in the peel and juice.

Foliar applications of Mn to moderately Mn-deficient orange trees increased yield of oranges, total soluble solids, pounds of total soluble solids per ton of fruit, and Mn concentration in the leaves, peel, and juice, and decreased Cu and N concentrations in the subsequent new-flush of leaves.

Zinc foliar sprays on moderately Zn-deficient orange trees increased the amount of ascorbic acid per unit volume in orange juice, increased Zn concentration in the new-flush of leaves, peel, and juice, but decreased the percent of juice by weight, Mn concentration in the new-flush of leaves, Mn concentration in the peel, and N concentration in the juice.

Foliar applications of urea to Valencia orange trees increased the yield of oranges.

Foliar applications once a year of Mn and Zn, alone, or in mixtures, corrected Mn and Zn deficiency symptoms on sprayed leaves but failed to prevent symptoms from developing on the subsequent new spring-flush of leaves.

U. Calif., Citrus Res. Cent. and Agr. Expt. Sta., Riverside, Calif.

101. Awad, M. M., and Kenworthy, A. L. CLONAL ROOTSTOCK, SCION VARIETY AND TIME OF SAMPLING INFLUENCES IN APPLE LEAF COMPOSITION. *Proc. Amer. Soc. Hort. Sci.* 83: 68-73. 1963.

The influence of clonal rootstocks EM I, II, V, VII, XIII, and XVI and scion varieties on the leaf composition of apple trees were evaluated. The scion varieties were Northern Spy, Red Delicious, Jonathan, and McIntosh. Leaf samples were taken 4 times at 2-week intervals in 1959 and once (mid-July) in 1960. The elements determined were N, K, P, Ca, Mg, Mn, Fe, Cu, B, Mo, and Al.

Significant differences in leaf composition between trees on different rootstocks were obtained for K, P, Ca, Mg, and Cu. Scion varieties were found to affect, significantly, leaf composition values for all elements considered except P, Fe, Al, and Cu. Differences between varieties were particularly wide for leaf K when leaf composition for all the elements was considered, Red Delicious had a relatively high nutrient level, Northern Spy and Jonathan had an intermediate level, and the level of McIntosh was intermediate to low.

The numerical differences obtained between clonal rootstocks and scion varieties in affecting leaf composition were not, in general, large enough to indicate a need for a change in leaf composition values for diagnostic purposes on the basis of rootstocks differences. These differences in scion varieties, however, should be recognized.

Leaf sampling for nutrient diagnosis can be done at the same time for trees growing on clonal rootstocks as that used for trees on seedling rootstocks.

Mich. State U., East Lansing, Mich.

102. Wilson, D. O., and Reisenauer, H. M. COBALT REQUIREMENT OF SYMBIOTICALLY GROWN ALFALFA. *Plant and Soil* 19(3): 364-373. 1963.

Alfalfa was grown in purified culture solutions to which different amounts of radioactive Co were added. Treatment effects were evaluated by measuring the yield, N, and Co

content of the plant tops; and the weight, volume, and leghemoglobin content of the root nodules. The Co requirement of symbiotic N fixation was met with 10 p.p.t. of the element in the rooting medium; this amount gave plants containing 0.0005 p.p.m. of Co in their whole tops and 0.008 p.p.m. of Co in their leaves. Leghemoglobin was found in measurable amounts only in nodules which were fixing N at the time of harvest. The level of added Co had no effect on the weight or volume of root nodules formed, nor were the Co levels supplied related to the leghemoglobin content of the nodules.

Wash. State U., Pullman, Wash.

103. Ståhlberg, S. STUDIES ON THE RELEASE OF BASES FROM MINERALS AND SOILS: V. THE UPTAKE OF POTASSIUM BY CLOVER FROM DIFFERENT MINERAL-PEAT AND SOIL-PEAT MIXTURES. *Acta Agr. Scandinavia* 13: 391-403. 1963.

Some pot experiments with red clover cultivated on mixtures of soils or minerals, Sphagnum peat, and quartz sand were made. Other nutrients than potassium were added in liberal amounts while the only source of potassium was the clay soil or mineral added.

The soils used were two clay soils, one post-glacial and one glacial clay. The post-glacial clay was much lower in exchangeable and hydrochloric acid soluble nonexchangeable potassium than the glacial clay and was also able to fix much more potassium than the latter.

The minerals used were biotite, muscovite, and microcline, which were crushed or ground, washed, and dried. The particle size distribution was roughly estimated from the amount of hydrochloric acid soluble nonexchangeable potassium in each material and "an average particle size" of about 0.006-0.060 mm. for muscovite, 0.006-0.020 mm. for biotite, and 0.002-0.006 mm. for microcline.

Soils and minerals were added to give the same amounts of exchangeable potassium per pot (with exception for biotite). Three different levels of exchangeable potassium were used, namely 100, 200, and 400 mg./pot (42, 84, and 168 mg./pot for biotite).

Equal amounts of other nutrients than potassium were added to the different mixtures and red clover was grown. The yields of clover increased with increasing amounts of potassium-bearing minerals added. Without any addition of soil or potassium mineral, the plants died at a very early stage and no yield was obtained. The yields were considerably lower when potassium was added in the form of biotite, muscovite, or microcline than when it was added in the form of clay soils.

Lower yields were obtained on the mixtures with glacial than on the corresponding mixtures with post-glacial clay.

Biotite was superior to all other materials investigated as a source of potassium. Much more than the exchangeable potassium was taken from the very small amounts of biotite in the mixtures (0.7 to 2.7 percent).

In the case of muscovite, which was most concentrated of all the materials with respect to exchangeable potassium, the clover plants could utilize the very small amounts (0.4 to 1.6 percent) of the mineral in the mixtures very effectively. More potassium was taken up from the muscovite mixtures than from the mixtures with post-glacial clay with equal amounts of exchangeable potassium (with exception for the smallest addition of muscovite) in spite of the lower yields.

From microcline, considerably more potassium was taken up than from muscovite.

Inst. Pedology, Royal Agr. Col., Uppsala, Sweden

104. Yates, M. G., and Hallsworth, E. G. SOME EFFECTS OF COPPER IN THE METABOLISM OF NODULATED SUBTERRANEAN CLOVER. *Plant and Soil* 19: 265-284. 1963.

A study was made of the effect of varying levels of copper supply on the soluble amino acids, carboxylic acids, and sugars of subterranean clover (var. Mt. Barker).

The effect in all cases varied with the supply of combined nitrogen. Although plants receiving nitrate nitrogen showed the usual accumulation of amino acids where copper was deficient, those relying on symbiotic fixation for nitrogen showed instead a continuous increase in soluble amino acids correlated with the level of copper. Increase in this level also increased the level of sugars and reduced that of the carboxylic acid.

In the soluble amino-acids of the nodule, glutamic acid, α -alanine, and γ -amino-n-butyric acid all increased within 24 hours of increasing the copper supply to the plant, but that only for the latter did this effect extend to the leaves of non-nodulated plants.

The rate of incorporation of label from C-14 glucose into the soluble amino-acids and protein of isolated nodules was shown to be roughly proportional to the copper supply.

McCollum Pratt Inst., John Hopkins U., Baltimore, Md.

105. Kubota, J., Lemon, E. R., and Allaway, W. H. THE EFFECT OF SOIL MOISTURE CONTENT UPON THE UPTAKE OF MOLYBDENUM, COOPER, AND COBALT BY ALSIKE CLOVER. *Soil Sci. Soc. Amer. Proc.* 27: 679-683. 1963.

The effect of soil moisture level on the uptake of Mo, Cu, and Co by alsike clover was investigated in a greenhouse experiment with two Brown Podzolic soils from New Hampshire and a Weisenboden and a Brown soil from Nevada. A wet soil condition increased the Mo in the soil solution and plant Mo content on all four soils. The Co concentration in the soil solution was higher in pots maintained at the high moisture level than at the low moisture level. This increase in Co concentration with soil wetness was reflected in alsike clover, over four cuttings, on the two Brown Podzolic soils, but not in plants from the two Nevada soils. Copper contents in the plants and in the soil solution did not differ consistently because of soil wetness.

SCS, USDA, Ithaca, N.Y.

106. Cole, C. V., Grunes, D. L., Porter, L. K., and Olsen, S. R. THE EFFECTS OF NITROGEN ON SHORT-TERM PHOSPHORUS ABSORPTION AND TRANSLOCATION IN CORN (ZEA MAYS). *Soil Sci. Soc. Amer. Proc.* 27: 671-674. 1963.

Short-term P uptake studies were conducted with intact 1-month-old corn plants of differential N and P composition. Supplemental N pretreatments producing increased growth rates and higher levels of N in the plant stimulated the rate of P uptake per unit dry weight of root more than did a tenfold increase in P concentration in the external solution. Nitrogen pretreatments caused five-to tenfold increases in rate of P translocation to the tops during the uptake period. The presence of nitrate or ammonium ions in the test solution during the uptake period had negligible effects on P uptake rates. Phosphorus uptake rates were highly correlated with total N level in the roots. The stimulation of P uptake rates with higher plant N levels suggests a connection between N metabolism and P uptake processes.

SWCRD, ARS, USDA, Fort Collins, Colo., 80521

107. Haddock, J. L. THE INTERRELATIONS BETWEEN NITROGEN AND POTASSIUM ON THE QUALITY OF SUGAR BEETS. 14th Ann. Fert. Conf. Pacific Northwest, Idaho Falls, Idaho, July 9-11, 1963 Proc. pp. 77-88. 1963.

In an attempt to relate chemical composition of sugar beet leaf petioles to quality of sugar beet roots, simple correlation coefficients were calculated. The quality factor for potassium in leaf petioles was more closely associated with root sucrose and purity percentages than was potassium composition in terms of me. per 100 grams of dry tissue. Soluble organic and nitrate nitrogen in me. per 100 grams of plant tissue, quality nitrogen, quantity factor, and N:K ratio of beet leaf petioles were all negatively associated with sucrose and purity percentages of sugar beet roots. Soluble potassium quality of leaf petioles was positively related to root sucrose and purity percentages.

Multiple correlations showing the degree of association among chemical quality and quantity factors of leaf petioles and blades, and sucrose and purity percentages of roots favored the use of leaf petioles in preference to leaf blades. From 60 to 85 percent of the variation in root sucrose and purity percentages were associated with variations in nitrogen, phosphorus, and potassium quality and quantity factors, and N:K ratios of leaf petioles.

Increasing potassium concentration in leaf petioles favored, and increasing nitrogen concentration depressed, both sucrose and purity percentages of beet roots. Nitrogen exerted an overriding influence on sucrose percentage at high concentration, obscuring any beneficial influence which might result from high potassium. However, increasing potassium concentration in leaf petioles appeared to exert a favorable influence on purity percentage at all levels of nitrogen studied.

SWCRD, ARS, USDA, Logan, Utah, 84321

108. Stebbins, R. L., Johnson, G., and Johnson, D. K. RESPONSES OF PEACH TO APPLICATIONS OF NITROGEN AND CHELATED IRON IN COLORADO. Proc. Amer. Soc. Hort. Sci. 82: 114-119. 1963.

The effects of N and Fe fertilization on Elberta peach trees growing on alkaline soil in Western Colorado were:

1. One lb. of N as $(\text{NH}_4)_2\text{SO}_4$ per tree banded along the irrigation furrows in February increased yellow leaf color, luminous reflectance of leaves, and decreased leaf green in comparison with unfertilized control trees and all other treatments. No significant increase in shoot growth was observed even though leaf N was increased.
2. The mean values for leaf color of trees which received 1/4 pound $\text{Fe Na}_2\text{EDDHA}$ were not significantly different from those of the controls, nor was there a significant difference in shoot length.
3. The mean value for leaf color of trees which received 1 lb. N as $(\text{NH}_4)_2\text{SO}_4$ plus 1/4 pound $\text{Fe Na}_2\text{EDDHA}$ was not significantly different from that of the controls. However, shoot growth was increased.
4. Leaf yellow and luminous reflectance of trees which received 2 lb. N as $(\text{NH}_4)_2\text{SO}_4$ plus 1/2 lb. $\text{Fe Na}_2\text{EDDHA}$ were less than those of the control trees, and shoot growth was increased.
5. The total tannins, polyphenolase activity, rate of browning, color, and flavor measurements were reported.

Oreg. State U., Agr. Expt. Sta., Corvallis, Oreg.

109. Embleton, T. W., Labanauskas, C. K., Jones, W. W., and Cree, C. B. INTERRELATIONS OF LEAF SAMPLING METHODS AND NUTRITIONAL STATUS OF ORANGE TREES AND THEIR INFLUENCE ON THE MACRO- AND MICRONUTRIENT CONCENTRATIONS IN ORANGE LEAVES. *Proc. Amer. Soc. Hort. Sci.* 82: 131-141. 1963.

Four- to 5-month-old leaves from nonfruiting terminals of Valencia and Washington Navel orange trees were found to be considerably higher in concentrations of N, P, K, and Cu, and lower in Ca than the same age leaves from behind young fruits. Similar comparisons for Mg, Zn, Fe, Mn, and B were not consistent.

Leaves from behind Valencia fruit, whether young or old, had significantly lower dry weight, N, P, K, Zn, Cu, Fe, and B, and significantly higher Ca and Mg than leaves of comparable age from terminals of nonfruiting growth.

Five-month-old Valencia leaves from nonfruiting growth were significantly higher in N, P, K, and Zn, and significantly lower in Ca, Fe, Mn, and B than 17-month-old leaves from nonfruiting growth. Five-month-old leaves immediately behind young fruit was significantly higher in P, K, and Zn, and significantly lower in N, Ca, Mg, Cu, Fe, Mn, and B than 17-month-old leaves immediately behind old fruit.

Washington Navel orange 4-month-old terminal leaves from nonfruiting growth were considerably higher in dry weight per leaf, N, P, K, and Cu, and slightly but significantly lower in Fe and B than the same age leaves immediately behind young fruit.

Washington Navel orange leaves immediately behind young fruit were higher in Ca and Mg, and lower in N, P, K, and Cu than the 3rd or 4th leaf behind young fruit.

There were gradients in the concentrations of N, Ca, Mg, and Cu, Mn, and B between the terminal Valencia leaves of nonfruiting growth and the 5th or 6th leaves back of the terminal; the N gradient from nonfruiting growth was not great and there was no significant gradient for P and K. There were large gradients in N, P, K, Ca, and Cu between the first Washington Navel leaves behind the fruit and the 3rd and 4th leaves behind the fruit.

A wide difference between the two common methods of leaf sampling was apparent in the levels of nutrient elements in the leaves.

U. Calif., Citrus Res. Cent. and Agr. Expt. Sta., Riverside, Calif.

110. Fleming, J. W. ANALYSIS OF CONCORD GRAPE PLANT SAP FOR DIAGNOSIS OF NUTRIENT STATUS. *Proc. Amer. Soc. Hort. Sci.* 83: 384-387. 1963.

The sap of the Concord grape plant flows readily in the growing season shortly before and after shoot growth starts and samples can be collected in a few minutes. With the use of the flame spectrophotometer, spectrograph, and other specialized equipment the nutrient level of the sap may be determined rapidly. Since the sample can be collected early in the growing season nutrient difficulties may also be corrected early in the season. The grape plant can be made to "bleed" even after considerable shoot growth by removal of the new shoots from a cane; therefore, sap analysis is not limited to the period before shoot extension.

Preliminary work was conducted to investigate the possibility of using the grape plant-sap for nutrient diagnostic analysis.

Sap from the Concord grape plant at the beginning of the growing season contained sufficient concentrations of Ca, Mg, K, P, and N for analysis.

The concentration of N, K, and P in the sap was increased by the application of these respective nutrients to the soil.

Significant correlations between the K or P content of the sap and the respective element content of leaves and petioles developing later in the season were found.

U. Ark., Fayetteville, Ark.

111. Maynard, D. N., Gersten, B., Young, R. E., and Vernell, H. F. THE INFLUENCE OF PLANT MATURITY AND CALCIUM LEVEL ON THE OCCURRENCE OF CARROT CAVITY SPOT. Proc. Amer. Soc. Hort. Sci. 83: 506-509. 1963.

Experiments were conducted in the greenhouse and field to determine the influence of Ca and K accumulation with time on the occurrence of carrot cavity spot. An increase in the incidence of cavity spot occurred as the time period between seeding and harvest was increased. This was associated with an increased accumulation of K and a decreased accumulation of Ca. It was suggested that the cavity spot disorder of carrot roots is a manifestation of Ca deficiency; which may be induced by excess K uptake during the ontogeny of the carrot plant.

Mass. Agr. Expt. Sta., U. Mass., Amherst, Mass.

112. Kushman, L. J., and Ballinger, W. E. INFLUENCE OF SEASON AND HARVEST INTERVAL UPON QUALITY OF WOLCOTT BLUEBERRIES GROWN IN EASTERN NORTH CAROLINA. Proc. Amer. Soc. Hort. Sci. 83: 395-405. 1963.

Wolcott blueberries, harvested at 3-, 6-, 9-, and 12-day intervals at Currie, N.C., exhibited little difference in yield, dry weight, and soluble solids, but increasing the harvest interval increased size of fruit, sugars, and pH, and decreased total titratable acidity and keeping quality. Harvest interval and season influenced the distribution of fruit sizes, and the pH and keeping quality of sized fruit. Differences in tartness of fruit harvested at different intervals but not in sweetness or acceptability could be detected by taste. Keeping quality was correlated with soluble solids: acid ratio.

Jr. Author, N.C. State Col., Raleigh, N.C.

113. Stockinger, K. R., MacKenzie, A. J., and Cary, E. E. YIELD AND QUALITY OF SUGAR BEETS AS AFFECTED BY CROPPING SYSTEMS. J. Amer. Soc. Sugar Beet Techol. 12(6): 492-496. 1963.

Cropping systems influenced yield and quality of sugar beets on Holtville soil by their influence on the availability and supply of soil nitrogen. The cropping systems which added nitrogenous organic matter or had residual nitrogen from high fertilizer applications increased the supply of available soil nitrogen and increased sugar beet yields, especially at low rates of applied nitrogen. These differences in yield due to cropping systems were overcome by the application of additional nitrogen fertilizer. At 420 pounds of nitrogen per acre, there was no significant difference in yield for any cropping system. This indicates that the benefits from alfalfa, sesbania, or steer manure were mainly due to the addition of nitrogen to this soil. The nitrogen from these organic sources had no apparent advantage over inorganic fertilizer nitrogen. Any benefits from these treatments other than nitrogen, were not reflected in yield or quality of sugar beets.

Southwestern Irrig. Field Sta., SWCRD, ARS, USDA, Brawley, Calif., 92227

Soil Classification

SEE ALSO 47, 51, 67, 69, 75, 84, 88, 90, 92, 103, 130, 136, 142, 143, 147, 150, 153, 154, 155, 156, 157, 159, 160, 161, 162, 163, 169, 173, 184, 185, 195, 208, 216, 219, 228, 230, 272, 277, 278.

114. Millet, J. L., and Drew, J. V. CHARACTERIZATION AND GENESIS OF PAWNEE AND ADAIR SOILS IN SOUTHEASTERN NEBRASKA. *Soil Sci. Soc. Amer. Proc.* 27: 683-688. 1963.

Pawnee and Adair soils occur on gently sloping to rolling uplands in southeastern Nebraska. They have clay-textured subsoils and are somewhat similar morphologically except that Pawnee soil has a yellowish-brown subsoil, whereas Adair soil has a reddish-brown subsoil. Montmorillonite and illite are important minerals in the clay fraction of these soils.

Field studies indicate that Pawnee soil was formed in Kansan glacial till whereas Adair soil was formed in poorly sorted and clayey material derived from Kansan till. This poorly sorted material overlies Kansan till and was identified in Nebraska as the colluvial phase of the Loveland formation. The Loveland formation often has a reddish-brown color which is thought to be the result of weathering and soil formation during Sangamon time.

Petrographic data indicated that the subsoil of Adair soil was more weathered than the subsoil of Pawnee soil. These data suggest that Kansan till was protected from weathering during Sangamon time by colluvial and upland (eolian) phases of the Loveland formation. Pawnee soil occurs in places where Kansan till was exposed by subsequent geologic erosion whereas Adair soil occurs in clayey remnants of colluvial-phase Loveland.

Soil Survey Lab., SCS, USDA, Lincoln, Nebr.

115. Ojakangas, R. W. PETROLOGY AND SEDIMENTATION OF THE UPPER CAMBRIAN LAMOTTE SANDSTONE IN MISSOURI. *J. Sedimentary Petrology* 33(4): 860-873. 1963.

The Upper Cambrian Lamotte Sandstone of Missouri is a time-transgressive marine orthoquartzite sandstone containing arkose sandstones and conglomerates in its lower part. In the outcrop area in southeastern Missouri, minor feldspathic quartzose sandstones occur throughout the formation and dolomitic and glauconitic sandstones occur at and near the top. The Lamotte Sandstone and its equivalents were deposited on a peneplaned Precambrian surface which sloped to the east-northeast in Missouri and to the south in southern Wisconsin and Minnesota. The sandstone thickens from less than 100 ft. in western Missouri to 400-500 ft. in eastern Missouri.

Cross-bedding data obtained on the outcrop area show that the currents which deposited the orthoquartzites flowed to the south, whereas those which deposited most of the arkoses flowed to the north. These arkoses were derived from the tourmaline-poor igneous rocks of the adjacent St. Francois Mountains. Feldspathic quartzose sandstones were formed by reworking of arkosic detritus and mixing with well-rounded quartz sand. The orthoquartzite sandstones are a mixture of minor first cycle and dominant "second cycle" components. The non-opaque heavy mineral suite of the orthoquartzites is composed of well-rounded zircon and tourmaline, the latter exhibiting some abraded overgrowths, and only minor amounts of angular heavy minerals. Well-rounded quartz is abundant and a few grains have abraded overgrowths. Tourmaline-bearing Precambrian sandstones in the Lake Superior region were probably the principal sources. Other Precambrian rocks in that area and in Missouri, Iowa, Oklahoma, Kansas, Nebraska, and South Dakota may have supplied additional detritus.

Stanford U., Stanford, Calif.

116. Easterbrook, D. J. LATE PLEISTOCENE GLACIAL EVENTS AND RELATIVE SEA-LEVEL CHANGES IN THE NORTHERN PUGET LOWLAND, WASHINGTON. *Geol. Soc. Amer. B.* 74(12): 1465-1483. 1963.

During the late Pleistocene the Vashon glacier, a lobe of Cordilleran ice which at its maximum was 5,300-7,000 feet thick in northern Washington, occupied most of the Puget Lowland. During a late stage in the recession of the glacier, when the ice was no more than a few hundred feet thick, marine waters entered the area floating the ice. Organisms living on the sea floor were incorporated in glaciomarine drift deposited beneath the floating ice. Radiocarbon dates from shells in the drift indicate an age of $11,660 \pm 350$ years (W-996).

Several hundred feet of emergence followed, during which fluvial and lacustrine sediments were deposited. A radiocarbon date from wood at the base of these sediments indicates deposition had begun by $11,640 \pm 275$ years ago (W-940).

A readvance of ice into northern Washington from British Columbia coincided with submergence of the lowland. Marine water and floating ice again covered the area depositing a second glaciomarine drift in places now at least 400 feet, and perhaps as high as 600 feet above sea level. Radiocarbon dates of $11,800 \pm 400$ (I-1037) and $10,370 \pm 300$ (I-1035) were obtained from wood in the deposits of two localities.

Emergence and deposition of till and outwash occurred near the Canadian border about 11,000 years ago.

Radiocarbon dates and stratigraphic relationships suggest that 350 feet of emergence, 500-700 feet of submergence, and 500-700 feet of emergence occurred in a period of only 1,000-2,000 years. These changes in relative sea level during such a short period may have resulted from a combination of two opposed tendencies, isostatic uplift of the land due to glacial unloading and eustatic rise of sea level, superimposed on tectonic movement.

Western Wash. State Col., Bellingham, Wash.

117. Mathers, A. C., Gardner, H. R., Lotspeich, F. B., Taylor, H. M., Laase, G. R., and Daniel, R. E. SOME MORPHOLOGICAL, PHYSICAL, CHEMICAL, AND MINERALOGICAL PROPERTIES OF SEVEN SOUTHERN GREAT PLAINS SOILS. *U.S. Dept. Agr., Agr. Res. Serv. ARS 41-85*, 63 pp. 1963.

Morphological, physical, chemical, and mineralogical characteristics of seven Southern Great Plains soils were given.

The data were the result of a project to characterize soils where dense, hard layers form immediately below depth of plowing. Immediate objects of the research project were: (1) To compare soil properties within these hard or dense layers with those of layers immediately above or below; (2) to compare properties of soils containing these dense or hard layers with those of nearby virgin sites of the same soil type; and (3) to characterize physical, chemical, and mineralogical properties of soils subject to formation of these dense or hard layers in order to determine the more susceptible soils.

This project, initiated in 1957, was terminated in 1960 when it became apparent, through analyzing the data and the results of other experiments that plant rooting habits on the selected soils are probably not determined by the measured variables but by excess soil strength.

Tables and soil descriptions.

SWCRD, ARS, USDA, Beltsville, Md., 20705

118. Rivers, E. D., Godfrey, C. L., and Kuntze, G. W. PHYSICAL, CHEMICAL, AND MINERALOGICAL PROPERTIES OF THE LAKELAND SOIL SERIES IN TEXAS. *Soil Sci.* 96: 395-402. 1963.

The Lakeland soils are formed in beds of sands and loamy sands of Eocene or younger ages in the Atlantic and Gulf Coastal Plain, and commonly have subsurface horizons of finer-textured materials. In the Seventh Approximation scheme, the soils of this series are classified as ultisols and entisols. The surface soil is sandy, light-colored, and varies in thickness from about 40 to 72 inches. The underlying finer-textured layer is variable in color, texture, consistence and thickness. The genesis of the finer-textured zone in the profile has long been debated by soil scientists.

A comparison of the data from Texas with data from other states shows that the greatest differences in particle-size distribution were for the profiles from Florida. In the upper sandy zone the clay content in Texas (2.0 percent average) was slightly less than in the other states except Florida (1.5 percent maximum). In the same zone the silt content (10.0 percent average in Texas) is about the same for all the states except Florida (3.3 percent maximum). No lithologic discontinuities were reported for the profiles from Texas.

The values for the chemical properties, except organic matter were generally slightly higher in Texas than in the other states. The pH values in the Texas profiles decreased with depth from a high of 7.0 to a low of 4.2. The maximum percentage of organic matter in the surface was 0.9 in Texas as compared with a minimum of 1.3 in the other states. In the upper sandy zone of the profiles in Texas, the cation-exchange capacity averaged 1.5 me./100 g. soil, and the maximum average for an exchangeable cation was 0.60 me./100 g. soil (calcium). No change in soil chemical properties could be related to the geographic distribution of the profiles in Texas.

Mineralogically all soils were quite similar in all of the states. Vermiculite, kaolinite, and quartz were the dominant clay-size minerals in the profiles of the other states. These three minerals plus chlorite and illite occur in important amounts in the clay fraction of Texas profiles. Gibbsite and goethite were present in small amounts in the other states but were not present in the Texas profiles. The absence of these two minerals in Texas indicates a possible lesser degree of weathering.

The origins of the finer-textured zones in Lakeland profiles in Texas were proposed as follows: (1) Pedogenetic deposition; (2) pre-existing strata, and (3) pedogenetic deposition on and/or intermingled with pre-existing strata. Uniformity of the data indicates pedogenetic deposition to be the dominant mode of origin in Texas.

Tables.

Soil Survey Lab., SCS, USDA, Lincoln, Nebr.

119. Hayes, M. H. B., and Mortensen, J. L. ROLE OF BIOLOGICAL OXIDATION AND ORGANIC MATTER SOLUBILIZATION IN THE SUBSIDENCE OF RIFLE PEAT. *Soil Sci. Soc. Amer. Proc.* 27: 666-668. 1963.

Natural profile columns of Rifle peat were obtained by driving asphalt-coated steel cylinders into the soil. The columns were incubated in the laboratory for a 102-day pre-amendment period. Carbon-14 labelled rye tissue was then mixed with the upper 6 inches of the soil profile and the columns were incubated for an additional 107 days. Irrigation water was applied and CO_2 evolution and organic matter in the drainage water were determined throughout the incubation period.

The pattern of CO₂ evolution and carbon balance relationships were considerably different from that obtained when small samples of disturbed, air-dried peat were incubated with plant tissue. There was no evidence of "priming action" due to the addition of tissue, but considerable amounts of organic matter were lost in the drainage water. The addition of plant tissue reduced the rate of biological oxidation of Rifle peat. Tile systems should be placed below a horizon which absorbs water-soluble organic matter if loss of organic matter in drainage water is to be controlled.

Jr. Author, Ohio Agr. Expt. Sta., Wooster, Ohio.

120. Shiflet, T. N. PROFITABILITY OF RICE AND NATIVE GRASS ON A DEEP-PEAT FRESH WATER MARSH SOIL. *J. Soil and Water Conserv.* 18: 244-246. 1963.

Range use of Class VII fresh water marshland in Louisiana is profitable even where it is necessary to control water levels by a system of levees and pumps. On the other hand, a rotation of rice farming and cattle is unprofitable due to relatively low rice yields and high production costs.

In a natural state, paille fine ranges could be expected to yield more profit than that shown because there would be no costs for levees and pumping. However, some additional expenses, such as cattle walkways, are necessary to fully utilize the marsh vegetation. Paille fine rangeland has a potential for producing 200 pounds of beef per acre annually when properly managed.

If fresh water marshes are drained and used for the production of crops, the peat soils will subside. This will cause the areas to become shallow lakes unless levees and pumps are used to control the water level.

The economic analysis given supports the present land capability classification of Fresh marsh, peat soils.

SCS, USDA, Lake Charles, La.

121. Mader, D. L. SOIL VARIABILITY--A SERIOUS PROBLEM IN SOIL-SITE STUDIES IN THE NORTHEAST. *Soil Sci. Soc. Amer. Proc.* 27: 707-709. 1963.

The degree of variability and its effect on accuracy of mean plot values for soil properties is an important problem needing evaluation for soil-site studies in the Northeast. The variability in soils sampled in a red pine plantation site study were discussed. Two profiles were sampled by horizon on each plot. Data were presented on the following soil properties: organic matter, N, silt and clay, exchangeable Ca plus Mg, cation-exchange capacity, and bulk density. Variability between plots was much greater than within plots. Some soil properties required a large number of samples for accurate estimation, others a small number. Variation did not differ greatly from A to B horizons.

Mass. Agr. Expt. Sta., U. Mass., Amherst, Mass.

122. Chepil, W. S., Burnett, E., and Duley, F. L. MANAGEMENT OF SANDY SOILS IN THE CENTRAL UNITED STATES. U.S. Dept. Agr. Farm B. 2195, 32 pp. 1963.

The management of sandy soils in the Central United States was given for cropland and pasture.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

123. Nash, V. E. CHEMICAL AND MINERALOGICAL PROPERTIES OF AN ORANGEBURG PROFILE. *Soil Sci. Soc. Amer. Proc.* 27: 688-693. 1963.

The Orangeburg soil was formed from unconsolidated sand of the Kosciusko formation. Weathering was intense due to the porous nature of the sand and warm, humid climatic conditions. X-ray diffraction, DTA, an alkali differential dissolution technique for amorphous constituents, heavy mineral analysis of sand, total elemental analysis of the clay fractions, and surface area measurements were used to study the soil type.

Minerals present in clay fractions were kaolinite, amorphous material, mica, a 14 \AA . montmorillonite-vermiculite-chlorite intergrade, and quartz, in the approximate order of abundance. Kaolinite and amorphous material increased whereas quartz decreased with profile depth in the coarse clay fraction. According to Jackson's weathering sequence, this would place the lower horizons in a higher weathering stage than the surface horizon. The evidence suggests that coarse quartz particles were being broken down to smaller particles resulting in this apparently anomalous sequence. The 14 \AA . intergrade mineral was more prevalent and stable in the surface horizons and apparently was formed from montmorillonite.

Miss. State U., Agr. Expt. Sta., State College, Miss.

124. Andrew, L. E., and Stearns, F. W. PHYSICAL CHARACTERISTICS OF FOUR MISSISSIPPI SOILS. *Soil Sci. Soc. Amer. Proc.* 27: 693-697. 1963.

Four silt loam soils in Warren County, Mississippi, were studied intensively to determine to what extent a soil series, as normally mapped by types, delimits the physical properties of the surface foot.

The degree of variation between individual samples implied that intensive sampling is necessary to typify physical properties of these soils. Means differed significantly between series in clay content, bulk density, and moisture-tension values. However, the range in values suggests that, for strength classification and similar purposes depending upon physical properties, similar textural types in different series can often be combined.

Memphis and Loring, designated upland soils, had considerably more clay than the bottom-land soils Falaya and Collins. As a result of erosion, variation in clay content in the plow layer was far greater in upland than in bottom-land soils.

FS, USDA, Atlanta, Ga.

125. Ford, H. W. THICKNESS OF A SUBSOIL ORGANIC LAYER IN RELATION TO TREE SIZE AND ROOT DISTRIBUTION OF CITRUS. *Proc. Amer. Soc. Hort. Sci.* 82: 177-179. 1963.

The soft organic pan layer found in the profile of certain soils of the flatwoods in Florida is a satisfactory medium for feeder root development under conditions of adequate drainage. About 50 percent of the entire feeder root system of each tree was found in the organic pan of Immokalee fs. The thickness of the organic pan averaged 17 inches under 12-year-old trees 14.9 feet in height compared to 8 inches under trees 11.9 feet tall. The thickness of the organic pan should be determined before considering the use of Immokalee fs for citrus production.

Fla. Citrus Expt. Sta., Lake Alfred, Fla.

126. Hussey, K. M. GROUND PATTERNS AS KEYS TO PHOTointerpretation OF ARCTIC TERRAIN. Iowa Acad. Sci. Proc. 69: 332-341. 1962.

Field observations made during the summers of 1955-61 substantiated the belief that angle of slope is the most significant factor in determining the type of ground pattern which regionally or locally features arctic terrain.

The factors of influence in any arctic terrain ground pattern are: Texture of regolith; type and thickness of vegetation mat; amount of surface and subsurface water; thickness of active layer; and angle of slope of the ground surface.

The angle of slope and texture of regolith determine surface and subsurface drainage to a large extent, and thus control the water loss from the area. The amount of water in the ground plays a large role in determining the type and amount of vegetation that can grow in the area and the thickness of the vegetation mat. The vegetation mat determines the thickness of the active layer. It is most thick (deep) where the mat is very thin, or absent.

Equidimensional ground patterns, circular frost scars, hummocks, ice-wedge polygons, and sorted stone nets develop on slopes of less than 2 degrees. With increase in slope to 4 degrees, these patterns become elongated, but not aligned nor continuous, i.e.--not stripes. Further increase in slope to 6 degrees is featured by such linear features as stripes (both sorted and non-sorted), and by development of steps. Steps become much more pronounced on steeper slopes, and solifluction lobes characterize slopes in excess of eight degrees.

Some changes in slope are very common and very local, so that a regional pattern peculiar to a slope of 2 to 4 degrees will be modified by a pattern of the locally developed steeper slope.

The different types of ground patterns can be used to determine terrain conditions of an unknown area from good air photos of the area.

Iowa State U., Ames, Iowa

127. Davis, R. D., and Bidwell, O. W. THE ENGINEERING APPLICATION OF AGRICULTURAL SOIL SURVEYS. Kans. Acad. Sci. Trans. 66(3): 401-408. 1963.

Engineering properties were determined and 10 of the 32 soil types and phases recognized in the Logan County, Kans., soil survey were classified.

The U.S.D.A. textural types assigned as a result of laboratory analyses or by field "feel methods" closely agreed with the mechanical analyses of all horizons of the ten soil profiles.

AASHO classification system results were used to detect significant engineering property differences between and within profiles. The three coarse-grained, or sandy soils, (Manter sil, Dwyer, ls, and Likes ls) varied greatly in engineering properties both within and among profiles, due primarily to segregating and layering by wind and water as the coarse parent materials were laid down, and to the effects of soil genesis, accumulation, removal, transformation, and translocation.

Results of the characterization of the loessial soils, Colby sil, Keith sil, Richfield sil, and Ulysses sil, as well as of the alluvial Bridgeport 1, revealed close similarity among series. Close correlation was found between the clayey nature and the classification of Promise c and Lofton silcl.

Some engineering properties and the resultant Unified and AASHO classifications for selected soil horizons were given in the tables.

Other interpretations which often are included in the engineering chapters of soil survey reports are tendency to slough or slide, suitability as a source of topsoil, and suitability for: Farm ponds; erosion control terraces; levees; irrigation; artificial drainage; building foundations; and sewage disposal beds.

The pedologic classification of the Soil Survey was sufficiently accurate for general engineering needs and estimates. For detailed needs, on-site sampling and testing was needed for design and construction of specific engineering works.

SCS, USDA, Lawrence, Kans.

128. Soil Conservation Service. SOIL SURVEY: * U.S. Dept. Agr., Soil Conserv. Serv. **

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FAIRBANKS AREA, ALASKA	41 pp.	Sept. 1963.
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These Soil Surveys are all published by the United States Department of Agriculture, Soil Conservation Service in cooperation with the local State agricultural and/or other cooperating agencies. All contain maps in addition to written text.

SCS, USDA, Inform. Div., Washington, D.C., 20250

EROSION CONTROL

Erosion Equation

129. Wischmeier, W. H. EROSION RATES AND CONTRIBUTING FACTORS IN SEMI-ARID REGIONS. Internat'l. Seminar Water and Soil Utilization. Brookings, S. Dak., July 18-Aug. 10. 1962. 9 pp. 1963.

Water erosion is a serious problem in semi-arid regions. Because of the smaller quantities of available soil moisture, cropping systems in these regions are different and usually much less varied than in humid regions. Erosive rainstorms do occur with sufficient frequency to result in excessive soil erosion from cropped lands not properly managed.

The soil-loss prediction procedure used successfully in much of the humid area of the United States as a guide for soil and water management planning appears to be readily adaptable to semi-arid conditions. Data and procedures for deriving locality values of the respective factors in the soil-loss estimating equation are such that their valid evaluation under semi-arid conditions is possible. Effects of climatic differences on cropping and on erosion rates are quantitatively credited by the new rainfall factor and cropping-management factor in the equation. Precision of the procedure can, however, be improved by further research investigations of the various factor relationships.

SWCRD, ARS, USDA, Lafayette, Ind., 47907

Wind and Water Erosion

SEE ALSO 6, 11, 122, 129, 139, 200, 208, 272,

130. Romashkevich, A. I. MICROSTRUCTURE AND MICROAGGREGATION OF SOILS AS RELATED TO SHEET EROSION AND THE FORMATION OF ALLUVIUM. Soviet Soil Sci. 10: 1156-1161. Dec. 1962.

The nature of the microstructure and microaggregation of a number of soils and their erosion products, was studied for their relationship to erosion resistance and to analyze Sideri's point of view with respect to the role of the soil components in the formation of microstructure and/or microaggregation. Samples of sod-podzolic soils, chernozems, chestnut soils, and their erosion products under natural runoff conditions were taken. The investigation of the microstructure and microaggregation of the soils and erosion products was conducted by means of polished sections. In all cases the texture, humus content, adsorbed bases, and water stability of soil aggregates were determined. The author concluded that:

1. Studies of the upper horizon of sod-podzolic soils, chernozems, and chestnut soils together with a parallel study of their erosion products under conditions of natural runoff revealed the following three types of microstructure: (1) Noncoagulated type without any microaggregation; (2) fragmentary type; and (3) granular type.
2. A direct relationship was observed between the type of microstructure of the soil and the water stability of its structure. The noncoagulated microstructure characteristically has a weak stability to water. The fragmentary microstructure shows a medium level of water stability. The granular microstructure, when there are several orders of microaggregates, is associated with maximum water stability.

3. The nature of alluvial deposits and their soils was closely linked to the microstructure of the soils eroded. Alluvial formations formed of materials originally removed from noncoagulated and fragmentary microstructural masses had undesirable physical properties. Optimum properties were exhibited by alluvial deposits and alluvial soils formed from materials eroded from soils with a granular microaggregation.
4. The micromorphological method of investigation can be used to determine the degree of erosion resistance of soils.

Scripta Technica Inc., 1000 Vermont Ave. N.W., Washington, D.C., 20005

131. Rich, L. R., and Reynolds, H. G. GRAZING IN RELATION TO RUNOFF AND EROSION ON SOME CHAPARRAL WATERSHEDS OF CENTRAL ARIZONA. *J. Range Mangt.* 16(6): 322-326. 1963.

The effects of grazing on runoff and erosion as determined on four experimental watersheds called Natural Drainages A, B, C, and D were given. These watersheds were located on the Sierra Ancha Experimental Forest about 40 miles north of Globe, Ariz. The authors concluded that:

1. Chaparral watersheds of central Arizona furnishes water for domestic, industrial, and agricultural use; forage for livestock; and habitat for game, particularly deer.
2. Chaparral watersheds were studied to test the effect of grazing with cattle and horses at two different intensities (80 percent and 40 percent use of perennial grasses during a spring-fall grazing season) on basal cover of perennial grasses, runoff, and erosion.
3. Vegetation, water, and sediment were measured on four watersheds between 1935-52. These watersheds, underlain by impervious quartzite, varied in size from 9.1 to 19.5 acres. Two watersheds were grazed while two served as checks.
4. From 1935-52, precipitation averaged 20.7 inches; streamflow on the ungrazed watershed C averaged 1.9 inches, 88 percent of which came from October-May. Sediment losses for all watersheds and all years averaged 17 to 132 tons per square mile per year.
5. Grazing 80 percent of the growth of perennial grasses reduced their basal cover. Grazing 40 percent of perennial grasses did not adversely affect basal cover.
6. Reduction in basal area of perennial grasses by grazing had no significant or practical effect on total water yield.
7. Proper grazing of perennial grass-shrub complexes in the chaparral of central Arizona had no measurable effect upon water production or erosion. Such a finding appears to justify application of the multiple use principle in management.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Tempe, Ariz.

132. Garcia, G., Hickey, W. C., Jr., and Dortignac, E. J. AN INEXPENSIVE RUNOFF PLOT. *U.S. Forest Res. Note RM-12*, 8 pp. 1963.

Construction and installation of a simple, inexpensive runoff plot for measuring surface runoff and erosion were described. One-by-eight-inch boards were used for the frame, supported by dirt mounded against the outside. A slotted, impregnated-fiber sewer pipe 4 inches in diameter formed the collection trough at an angle across the bottom of the 10-by-30-foot plot. Runoff flowed by gravity through a hose into collection barrels in a trench.

The materials considered best cost roughly \$26 per plot. One man-day was required to build one of these plots. Several other materials and shapes of collection troughs tested were discarded as impractical.

Eighty-four of these surface runoff plots have been in constant operation for 4 years. To date, no repairs have been necessary. Maintenance consists simply of removing Russian thistle plants that collect in the trenches, and an occasional mouse nest in the collection troughs.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo., 80521

SOIL MANAGEMENT

Cropping Practices

SEE ALSO 60, 61, 62, 143, 144, 242, 245.

133. Ligum, S. T. DURATION OF THE RESIDUAL EFFECT OF BASAL FERTILIZATION IN A CROP ROTATION ON SOIL FERTILITY, CHEMICAL COMPOSITION, AND YIELD OF SUGAR BEETS. Soviet Soil Sci. 7: 677-684. July 1962.

The total residual effect of organic and mineral fertilizers in a 10-field crop rotation on a leached chernozem soil after 4 years of systematic basal fertilization of manure + NPK, lasted 21 years after basal fertilization was discontinued. The root yield of sugar beets on plots of the "residual effect of basal fertilization" was higher than the control (with row but no basal fertilization) by 49 cntr./ha. (1,960 lbs/A.) while the sugar content of the roots (19.9 percent) was 0.3 percent higher.

The nutritive regime of the soil on plots of the "residual effect of basal fertilization" treatment 11 years after discontinuation of basal fertilization had a higher content of all the nutrients investigated than did the control. After 21 years, soil samples from the "residual effect of basal fertilization" had more available phosphorus but less available nitrogen and potassium than did the control.

The chemical composition of sugar beets after long residual effect of basal fertilization showed a decrease in the percentage of potassium and nitrogen. The phosphorus content remained the same or after a shorter residual effect (11 years) was higher than the control. The total removal of nutrients by sugar beets was higher than in the control regardless of the length of the residual effect of basal fertilization. A lengthening of the residual effect of fertilization to 21 years increased the efficiency with which the available nitrogen and potassium were used, but had no influence on the utilization of phosphorus in forming the roots. The prolonged residual effect of basal fertilization in a crop rotation suggests that basal fertilization should be applied only to the major crops in a rotation--sugar beets, corn, and winter wheat--and in such a way that the other crops could be more fully exposed to the residual effect of the fertilizers.

Scripta Technica Inc., 1000 Vermont Ave. N. W., Washington, D.C., 20005

134. Zakharchenko, I. G., Pirozhenko, G. S., and Sukhobrus, S. V. EFFECT OF CONTINUOUS CROPPING ON SOIL FERTILITY. Soviet Soil Sci. 7: 685-691. July 1962.

After 30 years of research at the Mironov Experimental Station in the USSR, it was reported that continuous cropping, both systematically fertilized and nonfertilized, had a much lower yield than did crops in a rotation. Continuous corn showed more stable yield which offers a possibility in repeated cropping in rotation.

The use of fertilizers enhanced the value of rotations in obtaining high yields.

Continuous row crops (corn, sugar beets) caused a greater loss of humus and nitrogen than did non-row crops (winter wheat). The annual addition of manure at the rate of 6 metric tons/ha. resulted in maintaining the original amount of humus and nitrogen under the continuous row crops.

No significant changes were detected in the quality of the organic matter under the different crops.

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135. Massee, T. W. CONTINUOUS CROPPING WITH NITROGEN IN THE WHEAT-FALLOW AREA OF SOUTHEASTERN IDAHO. 14th Ann. Fert. Conf. Pacific Northeast, Idaho Falls, Idaho, July 9-11, 1963. pp 17-26. 1963.

In 1954, an experiment was initiated to study conditions under which annual cropping might be successful. The following cropping treatments were tested: (1) Annual cropping (not-subsoiled); (2) annual cropping (subsoiled after harvest each year); and (3) crop after fallow (subsoiled post-harvest and post-fallow). Nitrogen, as ammonium nitrate, was applied to duplicate plots within the main cropping treatments, at rates of 0, 10, 20, 40, and 80 lbs. N/A. Moisture was sampled to a 6-foot depth by 1-foot increments on main tillage plots near planting and harvest times. The amount of moisture gained from harvest time to spring is shown in the table.

Table. Moisture storage in top 6 feet from harvest time until seeding time next spring. 1954-61.

<u>Rotation</u>	<u>Moisture</u>
Annually cropped	4.81
Annually cropped, fall subsoiled	6.70
Fallow, fall subsoiled	6.78
Cropped after fallow, fall subsoiled	7.50

When annual cropped plots were subsoiled, moisture storage was increased 1.89 inches. The "cropped-after-fallow" plots had gained only 0.72 inch more by fallowing one season.

Fallowing was grossly inefficient during the summer months (during the actual tillage period) when an average quantity of 1.69 inches of stored moisture plus summer precipitation (4.1 inches) was lost.

Where adequate moisture (more than 6 inches) was stored on annually cropped plots, it was economical to apply 20 pounds of N/A for increased yield and protein content of spring wheat. Where less than 6 inches of moisture was stored, annual cropping was not feasible.

In most cases, applying nitrogen to spring wheat grown on fallow did not give a marked yield or protein response.

SWCRD, ARS, USDA, St. Anthony, Idaho, 83445

Crop Residue Management

136. Mortensen, J. L. DECOMPOSITION OF ORGANIC MATTER AND MINERALIZATION OF NITROGEN IN BROOKSTON SILT LOAM AND ALFALFA GREEN MANURE. Plant and Soil 19(3): 374-384. 1963.

C-14 and N-15 doubly labelled alfalfa tissue at addition rates of 5 and 1 ton per acre was incubated in the laboratory for 72 days with virgin and cultivated Brookston sil. The

alfalfa tissue was more extensively decomposed in the virgin soils than in cultivated soil, but retention of tissue carbon was not affected by rate of addition. Percentage decomposition of organic matter in the virgin soil was greater than that in the cultivated soil. Addition of alfalfa tissue reduced decomposition of soil organic matter in proportion to the rate of addition and resulted in a gain of carbon in the incubation mixture. No "priming action" was noted.

An increase in the rate of tissue addition caused an increase in the amount of nitrogen mineralized from the tissue but had little effect on the amount of nitrogen mineralized from the soil. Nitrogen mineralized from the soil organic matter was preferentially immobilized during the latter part of the incubation period.

It appears that the organic matter content of the soil as well as the rate of tissue addition may regulate the "priming action" of green manures.

Ohio Agr. Expt. Sta., Ohio State U., Wooster, Ohio.

137. Khrusteva, L. A., and Luk'yanenko, N. V. ROLE OF PHYSIOLOGICALLY ACTIVE SUBSTANCES IN THE SOIL-HUMIC ACIDS, BITUMENS AND VITAMINS B, C, P-P, A, AND D-IN THE LIFE OF PLANTS AND THEIR REPLENISHMENT. Soviet Soil Sci. 10: 1137-1141. Oct. 1962.

The opinion has been widespread that organic matter in the soil has only an indirect effect on the life processes of plants, that it is not assimilated by plants, and that it plays no direct role in their vital activity. Today this concept has changed radically.

The concept has been changed as we have gained more knowledge about the following aspects of the problem: (1) The precise makeup of the humus in the soils and caustobioliths, the separation of individual compounds and establishment of the chemical structure of many of them; (2) the effect of these compounds on the vital activities of plants and the individual physiological functions of the plant organism; and (3) the study of conditions under which the effect of these substances is particularly clearly evident and becomes stable.

The time has arrived when we can say that, in addition to mineral elements, plants assimilate organic substances which carry out a very definite, often very important physiological function.

The authors' point of view on the role of humic acids, bitumens, and some vitamins in the life of plants was reached on the basis of many years of experimental work and theoretical analysis. The work led to the conclusion that the principal physiological function of these substances is that they relieve "oxygen deficiency" in plants.

The administration of vitamins that are lacking relieves diseases in man, so also the addition of the physiologically active substances of the soil and caustobioliths into the plant organism improves their vital activity. The plants grow better, develop faster, and give higher yield.

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138. Stewart, B. A., Johnson, D. D., and Porter, L. K. THE AVAILABILITY OF FERTILIZER NITROGEN IMMOBILIZED DURING DECOMPOSITION OF STRAW. Soil Sci. Soc. Amer. Proc. 27: 656-659. 1963.

A greenhouse study measured the extent to which fertilizer N-15 immobilized during decomposition of straw becomes available for plants. Less than one-half of the immobilized fertilizer N-15 was released for plant uptake during four successive typings in the greenhouse. The crops were beets, barley, and corn.

Fractionation of the soil N showed that about 75 percent of the N taken up by the plants was derived from the nondistillable acid-soluble N fraction. Fertilizer N-15 immobilized in this fraction was utilized at a faster rate by plants than the N initially present in this fraction.

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Tillage

SEE ALSO 195, 212.

139. Larson, W. E. ADVANCES IN MINIMUM TILLAGE FOR CORN. Amer. Seed Trade Assoc. 17: 41-51. 1962.

Many minimum tillage practices have been developed in recent years. If used where suited and properly carried out, minimum tillage had many advantages over conventional tillage. Increased surface water detention, greater plow layer storage, and a more rapid rate of water intake accounted for the lower measured amounts of runoff and erosion on minimum tilled soils as compared with conventionally tilled soils. Corn grain yields in the North Central States were about equal from minimum and conventionally tilled treatments.

SWCRD, ARS, USDA, Ames, Iowa, 50010

140. Blake, G. R. OBJECTIVES OF SOIL TILLAGE RELATED TO FIELD OPERATIONS AND SOIL MANAGEMENT. Netherlands J. Agr. Sci. 11: 130-139. 1963.

Tillage, in its broadest sense, includes all traffic on the soil required to grow the crop. Thus defined, most tillage is a necessary evil. If one could plant, fertilize, control weeds and insects, and harvest without touching the soil, it might be assumed that the crop would grow just as well. The big question is how to carry out the "indirect" tillage in the simplest possible way, with the least damage to the soil structure, and with the least cost.

Seeding, fertilizer application, thinning, cultivating, harvesting, and tillage for special purposes (such as erosion) are usually destructive of the porosity created by plowing. The researcher needs to seek ways to: (1) Omit unnecessary or least essential tillage; and (2) combine operations so as to reduce the number of trips over a field.

New seed, new fertilizer, new herbicides, new machines, and the reservoir of knowledge of basic soil science present the possibility of a revolution in tillage practices.

"Minimum tillage" experiments in the United States have aroused great interest among farmers in omitting unnecessary tillage, and in combining a number of tillage practices in the same trip. Yield decreases have, in most cases, failed to appear. Improved soil porosity, decrease in weed competition, and great reductions in water runoff and erosion have been additional bonuses. The results of these experiments might be successfully extrapolated to other soils, crops, and climatic conditions.

U. Minn., St. Paul, Minn.

141. Larson, W. E. IMPORTANT SOIL PARAMETERS FOR EVALUATING TILLAGE PRACTICES IN THE UNITED STATES. Netherlands J. Agr. Sci. 11: 100-109. 1963.

Soil parameters important in tillage practices for row crops were discussed for the seedling environment soil zone (row zone) and for the water management soil zone (intra-row zone). Mulches of crop residues, and ridge-furrow systems materially influenced the

temperature of the soil. The optimum soil temperature at the 10 cm. depth for maize growth early in the season was 23.3° C. If the soil temperature was materially below the optimum, slight changes in soil temperature due to tillage practice markedly affected the growth of maize early in the season. The secondary aggregate size and compacting pressure around the seed and seedling root influenced the total porosity and the size of the inter- and intra-aggregate pores. The size of the inter- and intra-aggregate pores, in turn, influenced water relations in the soil. The size of the inter-aggregate pores was related to the area of soil solution-seed and soil solution-seedling root contact. The total water transmission rate across the interface was probably related to the area of contact. Emergence of seedlings was often superior when compaction pressures were applied at seed level rather than on the soil surface.

Tillage tools can be used to create various microrelief in the water management soil zone to aid in the management of water. The potential amount of water that can be temporarily stored in the microdepressions is termed depression storage. Increased porosity, due to loosening a soil by tillage, acts as a reservoir for temporary storage of water during an intense rain.

SWCRD, ARS, USDA, Ames, Iowa, 50010

142. Drezgic, P., and Jevtic, S. THE INFLUENCE OF DEPTH OF PLOWING ON THE DEVELOPMENT AND YIELD OF WINTER WHEAT ON CHERNOZEM SOIL. Netherlands, J. Agr. Sci. 11: 157. 1963. (From Authors' Summary).

The influence of depth and method of plowing on development and yield of winter wheat was studied over a 4-year period. It was concluded that deep plowing to 35 and 45 cm. (14-18 in.) according to the method of soil amelioration with the proper distribution of the mineral fertilizers favored a more regular water supply to the plants because of increased moisture storage in the soil. The greater quantity of water supply during the growing period, in addition to other improved conditions in the soil with deeper plowing enabled the following:

1. Stronger development of the root system during the whole vegetation period; a more regular distribution of the roots over various layers including the plow layer; and a more regular ratio of roots to overground parts. A higher total and active absorbing surface of the root system and stronger and deeper penetration of the roots enabled a better supply of water and nutritive elements to the plant. As a result, the overground parts were better developed, including overground mass and higher photosynthetic surface (leaf-surface).
2. With a more regular ratio of roots to overground parts and with a better and more regular water supply to the plant during the vegetation period, the improved elements of yield were as follows: Greater number of ears per sq. m.; greater number of spikelets and grain per ear; and better grain development (greater weight of the individual grain) which finally resulted in higher yields per hectare.

The advantage of deep plowing was especially pronounced in the dry years. In the extreme moist year (1958-59), the value of deep tillage was not apparent.

Complete mimeographed text available from Tillage Lab., State Agr. U., Diedenweg 20, Wageningen, The Netherlands

143. Mihalic, V. IMPROVEMENT OF PARA-PODSOLS IN NORTH-WESTERN CROATIA. Netherlands J. Agr. Sci. 11: 158. 1963. (From Author's Summary).

Investigations showed that it was possible to create a new crop producing soil on para-podsols of North-West Croatia with tillage aimed at permanent amelioration by means of

deep plowing and manuring with commercial fertilizers. Previously held views, that on such soils deep tillage must be combined with liming and the application of organic matter were disproved.

Wheat was the crop in the first year, followed by maize fertilized with stable manure, and then a leguminous plant in the third year. While wheat repaid all investment costs in the first year alone, the costs of the improvement and fertilization should be distributed over several years.

Deep tillage ensured vertical drainage and allows deeper and stronger rooting. It does not, however, meet all requirements regarding quick drainage of surface water derived from precipitation. The ameliorative tillage should be combined with back-furrow plowing according to the Italian system called "abbaulatura" which leaves drainage ditches all around the tilled plots. The advantages of tile drainage, which is more expensive and rather complicated to install, should be studied in greater detail, although this experiment gave preference to ameliorative tillage combined with the "abbaulatura" system.

Complete mimeographed text available from Tillage Lab., State Agr. U., Diedenweg 20, Wageningen, The Netherlands

144. Hawkins, J. C., and Brown, N. J. TILLAGE PRACTICES AND MECHANIZATION. Netherlands J. Agr. Sci. 11: 140-144. 1963.

The introduction of herbicides has created an opportunity for great changes in tillage operations. It now becomes increasingly important to establish the minimum tillage requirements for maximum crop production.

Problems related to the plant root environment can best be solved by the measurement of basic physical properties such as the state of the soil water, soil air, soil temperature, and the mechanical resistance to roots and shoots instead of relying only on crop yields as a measure of tillage efficiency.

The introduction of herbicides challenges the moldboard plow as the most effective method of weed control, but its value as a method of burying damaged soil surfaces still remains. The harmful effects of the smearing and compaction of furrow bottoms in tractor plowing were discussed. Certain tillage operations such as levelling, carried out to help other mechanical treatment, can create poor plant conditions. The mechanical separation of potato tubers from clods in harvesters can be improved by preparing clod free seed beds and controlling weeds by means of herbicides. In specialized vegetable production, growers are achieving success by using a bed system of cultivation where a carefully prepared cropping area remains untouched until harvest.

Natl. Inst. Agr. Engin., Silsoe, Bedford, England

145. Burwell, R. E., Allmaras, R. R., and Amemiya, M. A FIELD MEASUREMENT OF TOTAL POROSITY AND SURFACE MICRORELIEF OF SOILS. Soil Sci. Soc. Amer. Proc. 27: 697-700. 1963.

Total porosity of the layer to be plowed was estimated from undisturbed cores collected before primary tillage on a Barnes 1 soil. Using a point quadrant instrument, soil surface elevation measurements were made before and after preplant tillage, and after each cultivation to determine the effects of tillage on total porosity of the plowed layer. Large

apparent differences in capacity to detain water, as inferred from total porosity, were observed among preplant tillages and among particular combinations of preplant and postplant tillage that are used in the western Corn Belt.

When total porosity of the plowed layer was measured in the ensuing fall and spring, relatively small changes in total porosity were observed. This result suggests that this physical property persists over a long time in a Barnes I.

To evaluate the effects of tillage on surface geometry and temporary water storage in surface depressions, macro and random surface roughness as measured by the point quadrant instrument were considered. Estimates of the standard error among logarithm of the elevation heights differed among tillage treatments. The standard error was suggested as an index of random roughness.

SWCRD, ARS, USDA, Morris, Minn., 56267

146. Barker, M. G. SOME EFFECTS OF PRIMARY CULTIVATIONS ON CROP YIELDS IN A FOUR-COURSE ROTATION. *J. Agr. Sci.* 61(2): 173-185. 1963.

The effects on crop yields of different basic methods of cultivation used in the preparation of seedbeds are being studied in a long-term experiment. The results of the first completed cycle of 4 years were discussed. The four basic methods of cultivation compared were: Plowing; rotary cultivating; cultivating; and disking. Each one of these was done, early and late, for each crop in two, four-course rotations which differed only in the cropping of 1 of the 4 years when potatoes were used in one case and a 1-year ley in the other. Each crop in the rotation (winter wheat, sugar beet, barley, ley or potatoes) was grown at two levels of fertilizer application and for two different weed control regimes. The soil was fairly easy to work, being of the Milton series of river gravels. The following conclusions were made:

1. Plowing was the most consistent method of providing a satisfactory basis for the final seedbed preparation. On the average, plowing led to the highest yields and disking the lowest, with rotary cultivating second and cultivating third.
2. The yields of cereals grown after root crops were not dependent on the method of basic cultivation used.
3. The effects of the cultivations on the yield of winter wheat after the ley appeared to be due to the extent to which the regrowth of rye-grass was controlled, the plow was the most effective.
4. Differences in the yields of the root crops following the basic cultivations appeared to be related to the depth and extent of compaction in the seedbed, the plow leading to the greatest depth of worked soil and the disk harrows the least.
5. The time at which the basic cultivations were done appeared to be of little importance.
6. The choice of potatoes or ley as a treatment crop had a marked effect on the yield of winter wheat; except on the plots which were plowed. Low yields followed the ley owing to the regrowth of rye-grass associated with the other basic methods of seedbed preparation.
7. The high level of fertilizer application led to higher yields of all crops than the low level.
8. When differences in crop yields were found following the different methods of cultivation, they appeared to be due to one or other of the methods failing to achieve a normally acceptable standard of seedbed preparation.

Sch. Agr., U. Cambridge, Cambridge, England.

Fertility Requirements for Conservation Farming

SEE ALSO 47, 49, 50, 65, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 133, 134, 135, 143, 195, 197, 232, 243.

147. Meagher, M. D., and Armson, K. A. THE EFFECT OF PHOSPHORUS PLACEMENT ON THE GROWTH OF WHITE SPRUCE SEEDLINGS. *J. Forestry* 61: 918-920. 1963.

White spruce seedlings were grown in a sandy soil that received super-phosphate fertilizer at four rates, and placed in three ways in the soil. Placing the fertilizer in a band of soil 1 inch below the surface produced the greatest seedling growth at all fertilizer levels. Surface placement resulted in the least growth and mixing the fertilizer throughout the entire rooting volume gave intermediate results.

Jr. Author, U. Toronto, Ontario, Canada

J. Indian Soc. Soil Sci. 11: 83-256. 1963.

This special issue of the Journal contains the papers from a Symposium on "Soil and Fertilizer Phosphorous." The following papers were given:

148. Raychaudhuri, S. P. ON THE CHOICE OF PHOSPHATIC FERTILIZERS. Planning Comm., New Delhi, India.

149. Sirur, S. S. PRODUCTION AND UTILISATION OF PHOSPHATIC FERTILIZERS IN INDIA. Fert. Assoc. India, New Delhi, India.

150. Dass, A. S. A NOTE ON THE OCCURRENCE OF PHOSPHATIC ROCKS IN PAONTA TEHSIL, SIRMUR DISTRICT, HIMACHAL PRADESH. Geol. Survey India, Lucknow, India.

151. Kanwar, J. S., Meelu, O. P., Baweja, A. S., and Singh, R. AVAILABILITY OF PHOSPHORUS IN FERTILIZER MIXTURES CONTAINING CALCIUM AMMONIUM NITRATE. Col. Agr. Ludhiana, Punjab, India.

152. Abraham, T. P., Khanna, R. C., and Bapat, S. R. RESPONSE TO PHOSPHATE APPLICATION OF DIFFERENT CROPS. Inst. Agr. Res. Statistics, New Delhi, India.

153. Datta, N. R., and Datta, N. P. RESPONSES TO PHOSPHATE IN RICE AND WHEAT IN DIFFERENT SOILS. Indiana Agr. Res. Inst., New Delhi, India.

154. Ghosh, S. K. EFFECT OF PHOSPHATIC FERTILIZERS ON THE YIELD OF PADDY AND SOIL CONDITIONS IN DIFFERENT REGIONS OF WEST BENGAL. State Agr. Res. Inst., Calcutta, India.

155. Rai, A. K., Prasad, C. R., and Mandal, S. C. EFFECT OF LIMING ON AVAILABILITY OF PHOSPHATE IN AN ACIDIC RED LOAM SOIL. Agr. Res. Inst., Kanke, Ranchi, Bihar, India.

156. Rajagopal, C. K., and Idnani, M. A. SOME ASPECTS OF PHOSPHORUS FERTILIZATION IN THE NILGIRI SOIL. Indian Agr. Res. Inst., Delhi, India.

157. Mehta, B. V., and Patel, J. M. SOME ASPECTS OF PHOSPHORUS AVAILABILITY IN GUJARAT SOILS. Inst. Agr., Anand, Gujarat, India.

158. Moorthy, C. K., Nair, P. K., and Jayaram, N. S. DOSE REQUIRED TO CORRECT PHOSPHORUS DEFICIENCY IN SOIL FOR RICE. Soil Conserv. Res. Cent., Bellary, Mysore, India.

159. Rao, T. M. V., and Rao, K. K. CORRELATION OF AVAILABLE PHOSPHORIC ACID IN SOILS WITH GRAIN YIELD AND PHOSPHORUS UPTAKE BY RICE. Agr. Col., Hyderabad, India.

160. Tamboli, P. M., and Mishra, V. K. PHOSPHATE REQUIREMENTS OF SOILS OF MADHYA PRADESH. M. P. Agr. Res. Inst., Jabalpur, Madhya Pradesh, India.

161. Læg, J., and Gautamdev. PHOSPHORUS STATUS OF SOME NORWEGIAN FOREST HUMUS SAMPLES. Agr. Col. Norway, Vollebekk, Norway.

162. Yadav, J. S. P., and Pathak, T. C. PHOSPHORUS STATUS OF CERTAIN FOREST SOILS OF INDIA. Forest Res. Inst., Dehra Dun, United Provinces, India.

163. Datta, N. P., and Srivastava, S. C. INFLUENCE OF ORGANIC MATTER ON THE INTENSITY OF PHOSPHATE BONDING IN SOME ACID SOILS. Indian Agr. Res. Inst., Delhi, India.

164. De, S. K. INDIA'S CONTRIBUTION TO THE STUDY OF PHOSPHATE FIXATION BY SOILS, CLAY MINERALS, HYDROUS OXIDES AND LIME. Chemical Lab., U. Allahabad, Allahabad, United Provinces, India.

165. Das, A. C. UTILISATION OF INSOLUBLE PHOSPHATES BY SOIL FUNGI. Bose Inst., Calcutta, India.

166. Rao, W.V.B. S., Bajpai, P. D., Sharma, J. P., and Subbiah, B. V. SOLUBILISATION OF PHOSPHATES BY PHOSPHORUS SOLUBILISING ORGANISMS USING P^{32} AS TRACER AND THE INFLUENCE OF SEED BACTERIZATION ON THE UPTAKE BY THE CROP. Indian Agr. Res. Inst., New Delhi, India.

167. Rao, B. V. V., and Rajan, S. V. G. PHOSPHORUS BUILD UP IN RED SOILS THROUGH FERTILIZATION AND ITS INFLUENCE ON CROP YIELDS. Dept. Agr., Bangalore, Mysore, India.

168. Patel, S. P., Ghosh, A. B., and Sen, S. EFFECT OF PHOSPHATE MANURING OF BERSEEM ON THE FERTILITY STATUS OF THE DELHI SOIL. Indian Agr. Res. Inst., New Delhi, India.

169. Biswas, T. D., Sharma, D. C., and Naskar, G. C. A PRELIMINARY STUDY ON THE EFFECT OF PHOSPHATE FERTILIZATION OF A LEGUME ON THE WATER STABLE STRUCTURE OF A SANDY LOAM SOIL. Indian Agr. Res. Inst., New Delhi, India.

170. Misra, S. G. STUDIES ON THE ROLE OF PHOSPHATES IN MODIFYING SOME OF THE SOIL PROPERTIES. U. Allahabad, Allahabad, United Provinces, India.

171. Hull, A. C., Jr. FERTILIZATION OF SEEDED GRASSES ON MOUNTAINOUS RANGELANDS IN NORTHEASTERN UTAH AND SOUTHEASTERN IDAHO. J. Range Mangt. 16(6): 306-310. 1963.

Three studies on soil fertilization of seeded grasses were made on mountainous rangelands.

Nitrogen at 20, 40, and 60 pounds per acre and phosphorus at 200 pounds of P_2O_5 per acre applied fall and spring on a 4-year-old stand of pubescent wheatgrass did not significantly affect grass yields, growth, or color.

Nitrogen, phosphorus, potassium, sulfur, and seven minor elements were applied fall and spring for 3 years as seedlings were made. Fertilizers did not increase stand establishment or affect the growth or color of seeded or native plants. Nitrogen at 100 pounds per acre applied in the fall or in the spring did not increase soil nitrogen the following summer. Phosphorus at 200 pounds of P_2O_5 per acre applied in the fall or in the spring increased the phosphorus in the topsoil.

Nitrogen at 100, 200, and 600 pounds, and P_2O_5 at 200 pounds per acre applied in the fall and in the spring on a 4-year-old mixture of seeded grasses made no significant difference in herbage yield. Nitrogen at the high rates significantly increased the protein and nitrogen content of the herbage and caused it to turn a darker green. Nitrogen applied in the fall was not in the top 42 inches of soil the next June or August. Part of the nitrogen applied

in May was still in the topsoil in August. Phosphorus applied in the fall or in the spring increased the phosphorus in the topsoil, but did not increase the phosphorus in the herbage.

CRD, ARS, USDA, Logan, Utah,

172. Kapusta, E. C. POTASH USE IN LIQUID FERTILIZERS. *Fert. Solutions.* 5(5): 6-9, 13. 1963.

Muriate of potash has proved to be one of the most satisfactory source of potash for use in the formulations of liquid fertilizers. Several reasons for its popularity are: (1) Muriate of potash is readily available in a low-cost, high purity agricultural grade; (2) it is readily transported and stored with conventional materials-handling equipment; and (3) solubility of muriate of potash is sufficient to permit production of most fertilizer formulations and grades.

The path of muriate of potash was traced from the ore mining stage through the refining processes to its ultimate use in liquid fertilizer mixtures. Some of its more important chemical and physical properties were discussed in relation to its use in liquid plant food solutions.

The major North American deposits of sylvinitite occur in New Mexico, Utah, and Saskatchewan, Canada.

High purity agricultural muriate of potash is a preferred source of potash for liquid fertilizer use. It is the least expensive form of fertilizer potash available for this use and may be conveniently and safely handled and stored in the fertilizer plant. Solubility limitations of muriate of potash contribute to the restrictions on the formulations and grades of solutions which may be produced. Some of these grade restrictions may be overcome by proper selection of the supplemental sources of nitrogen used in fertilizer solution manufacture.

Potash Co. Amer.

173. Longstaff, W. H. PRODUCTION OF NUTRITIOUS COASTAL BERMUDA GRASS ON HOUSTON BLACK CLAY. *Hoblitzelle Agr. Lab. B.* 18, 27 pp. 1963.

Results of a 3-year fertility management program on Coastal Bermudagrass grown on highly fertile Houston black clay soil indicate that:

1. All annual rates of nitrogen fertilizer significantly increased forage production. Annual forage yields were increased from 1.89 to 8.54 tons of air-dry hay per acre during the period of 1960-62.
2. The most efficient yield response to nitrogen was obtained by application of 80 pounds per acre of nitrogen after the first cutting. The highest total yield of forage was produced by application of 80 pounds per acre of nitrogen after each cutting.
3. An annual mean forage yield increase of 0.90 tons of hay was associated with each increment of 40 pounds of applied nitrogen in the spring.
4. An annual mean forage yield increase of 1.27 tons of hay was associated with increment of 40 pounds of applied nitrogen after the first hay cutting in June.
5. The protein content of the forage was increased with every addition of nitrogen fertilizer regardless of the time of season that it was applied.
6. Phosphorus content of the forage was highest in the first cutting and lowest in the last cutting. There was a significant reduction in phosphorus content of the forage associated with high rates of nitrogen fertilization.

7. The potassium content of the forage progressively decreased from year to year and from cutting to cutting during the year.
8. The application of fertilizer in early September insured increased forage production of sufficiently high quality to promote optimum beef gains during November and December.
9. Each dollar invested in nitrogen fertilizer returned \$3.42 to \$6.07. Net profit was increased from \$23 to \$88 per acre.
10. The inherent fertility of the Houston black clay soil can be exhausted under a strictly nitrogen fertilization program. High rates of nitrogen application required supplemental applications of phosphorus and potash fertilizer to maintain the proper balance of soil fertility.

Hoblitzelle Agr. Lab., Tex. Res. Foundation, Renner, Tex.

174. Scott, R. S., Cullen, N. A., and Davies, E. B. LONG-TERM STUDIES OF MOLYBDENUM APPLIED TO PASTURE: I. THE EFFECTS OF MOLYBDENUM AND LIME AND THEIR INTERACTIONS. *New Zealand J. Agr. Res.* 6: 538-555. 1963.

The effects on pasture of single and repeated applications of 0, 3/4, 1 $\frac{1}{2}$, and 3 tons/A. of ground limestone with and without 2 $\frac{1}{2}$ oz./A. of sodium molybdate were studied over an 8-year period.

Molybdenum alone gave a marked response which remained effective for 7 years. Three tons of lime gave a similar yield and proved effective for 5 to 7 years. The response from lime was slower than from molybdenum. In the presence of molybdenum, there was no response from lime.

Initial responses were in the white clover (*Trifolium repens* L.) and subsequently in the sown grasses. From the fifth year, white clover yields in the molybdenum alone treatment fell off relative to the lime treatments.

Mixed herbage Mo levels were increased by the application of lime or molybdenum, but appeared a poor guide to requirement. The highest level attained in the trial was 3.3 p.p.m., well below that associated with stock ill-health.

The optimum pH in the absence of molybdenum was 6.6; in the presence of molybdenum it was 5.7 or less. The effect of treatments on the molybdenum status of the soil was apparent using Grigg's method of extraction. Heavy liming accelerated downward movement of Mo.

Invermay Res. Sta., Taieri Agr. Cent., Dept. Agr., Mosgiel, New Zealand.

175. Scott, R. S. LONG-TERM STUDIES OF MOLYBDENUM APPLIED TO PASTURE: II. THE EFFECTS OF MOLYBDENUM AND LIME AND THEIR INTERACTIONS WITH DIFFERENT FORMS OF PHOSPHATES. *New Zealand J. Agr. Res.* 6: 556-566. 1963.

The main effects of lime and molybdenum and their interactions with North African, Nauru, and Christmas Island rock phosphates and superphosphate applied to pasture were investigated over a 5-year period on a molybdenum-deficient soil.

Marked responses followed the application of 2 $\frac{1}{2}$ oz. sodium molybdate/A. and a dressing in excess of 2 tons of lime/A. was necessary to give equal yield responses. The response acted through an increase in total clovers, particularly white clover (*Trifolium repens* L.)

All phosphate treatments responded markedly to molybdenum and 2 tons of lime/A. with superphosphate giving the highest yields and North African the highest of the rock phosphate treatments.

In the presence of applied molybdenum, no significant yield response followed the application of 2 tons compared with 5 cwt./A. of lime on the superphosphate treatment, and it was suggested that there was no benefit in raising the soil pH beyond 5.8. Rock phosphate yields were slightly depressed by the application of 2 tons of lime/A. in the presence of molybdenum.

Invermay Res. Sta., Taieri Agr. Cent., Dept. Agr., Mosgiel, New Zealand

176. Scott, R. S. LONG-TERM STUDIES OF MOLYBDENUM APPLIED TO PASTURE: III. RATES OF MOLYBDENUM APPLICATION IN RELATION TO PASTURE PRODUCTION. New Zealand J. Agr. Res. 6: 567-577. 1963.

Results were presented of an experiment conducted over a period of 7 years' investigating pasture yield responses from sodium molybdate applied to a soil, with a pH of 5.7, at rates ranging from 1/32-2 oz./A. The effect of reapplication of treatments after 4 years was also investigated.

A response was recorded to 1/32 oz., while maximum yields were obtained from 1 oz. To maintain high yields, reapplication of 1 oz./A. became necessary after 5 to 6 years.

Increasing the rate of application up to 1 oz./A. caused an increase in the percentage of clover in the sward and an increase in the ratio of white clover (Trifolium repens L.) to red clover (trifolium pratense L.). This was accompanied by an increase in the percentage of higher-fertility-demanding grasses.

Soil molybdenum levels reflected the amount of molybdenum applied at the higher rates.

Mixed herbage analyses showed the molybdenum content of a pasture treated with rates of sodium molybdate up to 2 oz./A. to be well below the levels associated with molybdenosis in stock.

Invermay Res. Sta., Taieri Agr. Cent., Dept. Agr., Mosgiel, New Zealand

177. Mikhnovskiy, V. K., Vysotskaya, P. N., and Kotova, V. V. INFLUENCE OF ORGANIC FERTILIZERS ON HUMUS FORMATION AND THE NITROGEN BALANCE IN SOD PODZOLIC CLAY LOAM. Soviet Soil Sci. 12: 1369-1373. Dec. 1962.

The influence of organic fertilizers on humus formation and the nitrogen balance in a sod podzolic clay loam was studied in Russia. The authors concluded that:

1. Systematic application of lupine and young cereal plants led to a stability with respect to heavy yields (yield decreased when application was discontinued), and also activated the biological processes.
2. Annual application of straw residue gave a decrease in yield. Discontinuing their application produced a positive residual effect.
3. The well decomposed lowland peat was a very inert material. When applied to the soil in pure form it had no effect on the yield of the indicator crop.
4. The role of organic materials in supplementing the nitrogen humus reserves in the soil was quite varied. Carbon losses (as a result of fertilizers and the soil itself) reach 20 to 30 percent of the initial content in the soil and fertilizers; an exception was the treatment with peat, where the carbon content during the experiment decreased in amounts equal to the control treatment. Losses of carbon from the soil and losses of applied organic materials were not always directly connected with the yields of tops. Independent of the fertilizer background, there was a close relationship between the amount of lost nitrogen and the amount of harvest.

The problem of increasing the effective fertility of sod podzolic soils, was closely associated with the supplement of the nitrogen content. The problem was not so much in the accumulation of the total content of nitrogen often fixed in inert forms as it was in the creation and systematic replenishment of its turnover reserve in the soil.

Scripta Technica Inc., 1000 Vermont Ave. N.W., Washington, D.C., 20005

178. Skryabin, F. A. EFFECT OF COMBINED APPLICATION OF MANURE AND MINERAL FERTILIZERS ON COTTON YIELD. Soviet Soil Sci. 11: 1285-1290. Nov. 1962.

Application of humus (pulverized manure) to cotton on sierozem soils in Russia, both under plowing land and as a top dressing in mixture with mineral fertilizers, was not as effective as the application of semi-decomposed raw manure under plowing land.

Application of humus in the form of organomineral mixtures was not appropriate. They apparently would be justified on those farms where the manure is infected with disease-causing organisms. If humus is available on the farm at the season for top dressing, it should be used as a top dressing in mixture with mineral fertilizers.

Scripta Technica Inc., 1000 Vermont Ave. N.W., Washington, D.C., 20005

179. Tietjen, C. THE NITROGEN EFFECT OF SIX LIQUID STABLE MANURES ON YIELD AND UPTAKE OF NITROGEN BY OATS IN POT EXPERIMENTS. Zeitschrift für Pflanzenernährung, Dungung, Bodenkunde, 98(2): 137-146. 1963. (From English Summary)

The nitrogen of six anaerobically prepared liquid stable manures with different quantities of straw was of different physiological effectiveness for crop production. According to the law of Mitscherlich, 28 to 54 percent of the nitrogen was effective.

The uptake of nitrogen by the plants and the physiological effective nitrogen were of nearly the same quantity. There was a negative correlation between the C/N ratios in the organic manures and the quantities of physiological effective nitrogen.

Aus dem Institut für Humuswirtschaft der Forschungsanstalt für Landwirtschaft, Braunschweig-Völkenrode, Germany.

180. Tietjen, C. THE NITROGEN EFFECT OF LIQUID ORGANIC MANURES ANAEROBICALLY PREPARED AT DIFFERENT TEMPERATURES. Zeitschrift für Pflanzenernährung, Dungung, Bodenkunde, 99(1): 54-66. 1963. (From English summary)

The physiological effectiveness of nitrogen in liquid organic manures, anaerobically prepared at different temperatures, was examined in pot experiments for the yields of oats and compared on the basis of the Mitscherlich equation $\log (A - y) = \log A - c(x + b)$. The author concluded that:

1. With four manures prepared of straw at 35°C ., decreasing values for the effective nitrogen portion was found with increasing rates of straw.
2. The effective nitrogen portion of cattle manure with straw prepared at 35°C . was of the same size as that of cattle manure without straw prepared at 10°C . The value of cattle manure with straw prepared at 10°C . was essentially lower.

3. Cattle manures of similar composition investigated in different years showed the same nitrogen effect when they were prepared with equal quantities of straw; differences between manures without straw were probably caused by different nitrogen shares originating in the liquid excrements.

Aus dem Institut für Humuswirtschaft der Forschungsanstalt für Landwirtschaft, Braunschweig-Völkenrode, Germany.

181. Tietjen, C. INVESTIGATIONS INTO THE EFFECT OF LIQUID FARMYARD MANURE ON ROOT CROPS AND CEREALS. *Zeitschrift für Acker- und Pflanzenbau* 118(2): 149-165. 1963. (From English Summary)

Comparisons were made between liquid and solid farmyard manures applied to root crops and cereals, by means of field experiments extending into one 6-year experiment and six 1-year experiments. The farmyard manures were applied on the basis of equal or of balanced quantities of organic material. There was a varied use of mineral nitrogenous fertilizers.

The reciprocal effect of organic manures and mineral nitrogen on yield showed a wide degree of variation being affected by the kind of manure, the nature of the crop, the weather conditions, and the level of yield.

The liquid forms of farmyard manure were distinguished by relatively high rates of the effective portion of nitrogen in the absence of mineral nitrogen or when it was given at low rates.

Aus dem Institut für Humuswirtschaft der Forschungsanstalt für Landwirtschaft, Braunschweig-Völkenrode, Germany.

Salinity and Alkali Problems

182. Dutt, G. R., and Doneen, L. D. PREDICTING THE SOLUTE COMPOSITION OF THE SATURATION EXTRACT FROM SOIL UNDERGOING SALINIZATION. *Soil Sci. Soc. Amer. Proc.* 27: 627-630. 1963.

A procedure utilizing a 1620 IBM computer was developed to predict the concentrations of Ca^{2+} , Mg^{2+} , and Na^+ in saturated extracts from soils undergoing salinization with waters containing Cl^- and SO_4^{2-} salts of one or more of the above cations. This procedure was used to predict the concentration in saturated extracts for soils to be salinized with various mixtures of salts. These predicted values were in agreement with experimentally determined values both in systems where the salts remained in solution and where gypsum was precipitated.

This procedure lends itself to routine analysis, and it should be possible to extend it to include other ions and slightly soluble salts that frequently are found in nature.

U. Calif., Davis, Calif.

183. Bower, C. A. DIAGNOSING SOIL SALINITY. *U.S. Dept. Agr., Agr. Res. Serv. Agr. Inform. B.* 279, 11 pp. 1963.

The proper management and treatment of salt-affected soils depends upon accurate knowledge of the nature and severity of the problem.

Visual observations of soils and of plants growing on them are rarely sufficient to diagnose a salinity problem adequately. The reliable method for diagnosis consists of making the right kinds of tests on representative samples of soil.

The value of soil tests depends upon the accuracy with which the samples represent conditions in the field.

Soil samples should be taken with care at several depths from places where the soil appears to be salt-affected and, for comparison purposes, from places where the soil appears to be unaffected.

Field information should accompany the soil samples.

Soil tests should give the electrical conductivity of the extract from saturated soil paste and the exchangeable-sodium-percentage.

If the exchangeable-sodium-percentage exceeds 10, additional tests are necessary for the soluble-calcium-requirement, pH reading, and lime content.

Soil tests should be interpreted properly, and maximum use made of field information.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

184. Babcock, K. L., and Schulz, R. K. EFFECT OF ANIONS ON THE SODIUM-CALCIUM EXCHANGE IN SOILS. *Soil Sci. Soc. Amer. Proc.* 27: 630-632. 1963.

Samples of Yolo fsl were leached with two series of solutions containing Na and Ca in which the composition varied. In each series, the composition of the solutions in the corresponding solutions was the same except that in one series the anion was chloride and in the other it was sulfate. After leaching the samples to equilibrium, the exchangeable sodium was higher for the sulfate series than for the chloride series. This was attributed to the effect of the different activity coefficients of the salts used.

U. Calif., Berkeley, Calif.

185. Johnson, D. D., and Guenzi, W. D. INFLUENCE OF SALTS ON AMMONIUM OXIDATION AND CARBON DIOXIDE EVOLUTION FROM SOIL. *Soil Sci. Soc. Amer. Proc.* 27: 663-666. 1963.

Osmotic tension reduced nitrate production and CO_2 evolution in a linear manner as the salt concentration of the soil increased. Nitrification rate showed the effects of individual salt species with NaCl being the most toxic. There was no evidence to support earlier reports that Na_2SO_4 was highly toxic.

Total microbial activity in the soil as measured by CO_2 evolution was much more tolerant of osmotic stress and shows less definite individual salt effects. Organisms contributing to CO_2 production showed a greater tolerance to salt than the nitrifiers and evolution was still measurable at 40-bars osmotic tension.

Microbial population in the calcareous soil had a greater salt tolerance than the organisms in the noncalcareous soil both for nitrification and CO_2 evolution.

Colo. Agr. Expt. Sta., Fort Collins, Colo.

186. Davis, S., and Pugh, W. J. INEXPENSIVE LAND PREPARATION FOR LEACHING. J. Soil and Water Conserv. 18: 246-247. 1963.

Many irrigation projects in the west are plagued with problems caused by an excess of salt and alkali in the soil. Most of these problems are directly associated with the application of water to the land. Provisions for drainage and land preparation to assure the water and soil salt level control essential for good irrigation were not made when these projects were initiated.

Salts that accumulate in the soil when excess water from seepage or over-irrigation raises the water-table must periodically be washed down or leached out of the soil. In general, the leaching operation may be more efficiently and completely accomplished if water is ponded on the surface. This may require expensive and extensive land preparation. Construction of level basins for leaching sloping land may cost from \$50 to \$200 per acre.

Through research, another method of land preparation for leaching sloping areas was developed. This method accomplishes the job quickly and at 5 to 10 percent of the cost of level basin preparation.

The actual layout for such a leaching system on a 1-percent slope on Billings soil was given.

In 1960, water was applied for 90 days to an area prepared for leaching according to the method described; over the entire leached surface an average of 30.3 inches of water entered the soil profile. In 1961, water was applied for 116 days; during that time, 27.8 inches of water went into the soil. The water was applied with no difficulty and with very little labor after the borders, saddle dams, and cross dikes were installed.

SWCRD, ARS, USDA, Riverside, Calif., 92502

187. Wilcox, L. V., and Resch, W. F. SALT BALANCE AND LEACHING REQUIREMENT IN IRRIGATED LANDS. U.S. Dept. Agr., Agr. Res. Serv. Tech. B. 1290, 23 pp. 1963.

The two criteria, salt balance (SB) and leaching requirement (LR), were compared as to their usefulness in describing and evaluating salinity conditions on an irrigation project.

The terms were defined and the interrelationship of the two was shown. Three methods for the calculation of salt balance are: (1) Output of salt minus input of salt, where observed values are used; (2) salt burden of the stream at the gaging station below the project minus the salt burden at the gaging station above the project; and (3) calculated output of salts minus the measured input of salts. Method 3 provides, in addition to salt-balance data, calculated values for both the volume and salt concentration of the drainage-return water. The accuracy of the three methods of calculation were compared by the use of data from irrigation projects in the Rio Grande Basin. Method 1 was of doubtful accuracy because of the near impossibility of obtaining satisfactory data for the drainage return. Methods 2 and 3 yielded very similar results for salt balance, the accuracy of which was limited only by the accuracy of the data. Except as noted, method 3 was used in order to obtain data for the leaching-requirement comparison.

The results of a cooperative investigation between the U.S. Bureau of Reclamation, the U.S. Section of the International Boundary and Water Commission, and the U.S. Salinity Laboratory were given.

Tabular data show annual values for SB and LR for each of the three divisions of the Rio Grande project in New Mexico and Texas for the 15-year period, 1938-52. The two criteria were discussed and compared in relation to salinity conditions on the projects.

A new term, "Salt Balance per Irrigated Acre" (SB_a), was introduced and defined. With this criterion, an estimate of the increase in concentration of salt in the saturation extract of the soil is possible. The cumulative SB_a values, covering the period 1951-59, were sufficiently high to account for the salinity conditions that developed during the drought years.

The authors concluded that: (1) Salt balance is a reliable and useful indicator of year-to-year trends in salinity conditions on irrigation projects. Salt-balance data can be interpreted in terms of the average increment of salt added to the soil extracts. And (2) leaching requirement is a reliable criterion for anticipating the leaching that would be necessary in order to prevent the salinity in the soil from exceeding a specified level.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

188. Leo, M. W. M. EFFECTS OF CROPPING AND FALLOWING ON SOIL SALINIZATION. *Soil Sci.* 96(6): 422-427. 1963.

The nature of water-salt movement in soil under cropped and fallowed conditions as related to soil salinization was studied in soil columns in the greenhouse.

A barley crop reached maturity with 4.2 inches of surface-applied water (artificial rainfall) in addition to a constant ground water supply from about 4 feet below the ground surface. Within the growing season, the average water loss from the columns growing barley was 7.9 inches greater than from the fallowed soil. Water loss decreased with increasing salinity of ground water.

The salt concentration of soil at harvest, as measured by electrical conductivity, was markedly affected by the salt concentration of the ground water and by the root system of the crop. The root system tended to accelerate water-salt movement from deeper soil horizons to the root-zones, while the fallowed soil tended to accumulate salt in the surface soil. Alternate cropping and fallowing, as commonly practiced in the Canadian prairies or similar regions facilitate the upward movement of salt from a high ground water table to the soil surface in relays and, therefore, contribute to soil salinization.

Isotopes, Inc. 123 Woodland Ave., Westwood, N. J.

189. Kadman, A. THE UPTAKE AND ACCUMULATION OF CHLORIDE IN AVOCADO LEAVES AND THE TOLERANCE OF AVOCADO SEEDLINGS UNDER SALINE CONDITIONS. *Proc. Amer. Soc. Hort. Sci.* 83: 280-286. 1963.

Avocado seedlings of 8 varieties were grown under saline conditions produced by irrigation with water containing 500 p.p.m. Cl as NaCl. The plants were graded for leaf scorch, growth was measured, and leaf samples were taken for analysis every 2 months.

In general, a close correlation was found between Cl content in the leaves and the grade of leaf scorch, except for the Mexican G1 7 variety. The seedlings of that variety showed the highest Cl content in their leaves and yet their damage rating was among the lowest.

The reliability of the various criteria used for valuation of salinity tolerance of avocado seedlings was discussed.

Natl. & U. Inst. Agr., Rehovoth, Israel.

190. Fanning, C. D., and Carter, D. L. THE EFFECTIVENESS OF A COTTON BUR MULCH AND A RIDGE-FURROW SYSTEM IN RECLAIMING SALINE SOILS BY RAINFALL. *Soil Sci. Soc. Amer. Proc.* 27: 703-706. 1963.

A cotton bur mulch facilitated leaching of soluble salts by rainfall. Salt concentration was reduced in the surface 30 inches of soil to a level below that considered detrimental to

growth of field crops. The high efficiency of salt removal by rainfall was attributed to flushing of salts from conducting pores when rains occurred combined with diffusion of salts from nonconducting to conducting pores between rains. Exchangeable Na percentage was also reduced to a low level. A ridge-furrow system facilitated leaching of salts from below the furrows, but less effectively than the mulch system. Salts returned to the leached zones beneath the furrows, whereas no appreciable return was evident under the mulch. Either practice may prove useful in management of saline soils.

SWCRD, ARS, USDA, Madison, Wis., 53711

Cover Crops and Green Manure Crops

SEE 136.

Climatic Influences

SEE ALSO 11, 32, 41, 68, 71, 72, 89, 190, 207, 236, 237, 238, 239, 259, 267, 292.

191. Osborn, H. B., and Reynolds, W. N. CONVECTIVE STORM PATTERNS IN THE SOUTHWESTERN UNITED STATES. *Internat'l. Assoc. Sci. Hydrol. B.* 8(3): 71-83. 1963.

In the Southwestern intermountain and high plains areas, precipitation is seasonal, with the major part of the rainfall occurring in the summer. Most winter precipitation occurs as low-intensity rain or snow along slow-moving cold fronts. Most summer precipitation occurs as short-duration, high-intensity thunderstorms from purely convective buildup or from convective cells developing along a weak fast-moving cold front. Almost all runoff occurs from the summer convective storms.

Since runoff-producing precipitation is of primary interest at the Southwest Watershed Research Center at Tucson, Ariz., the convective storms were studied. Duration, intensity, areal extent, movement, character, and return frequencies for varying volumes and intensities of these convective storms were analyzed from records from dense networks of recording rain gages in four study areas in Arizona and New Mexico. The primary study areas were the 58-square-mile Walnut Gulch Experimental Watershed at Tombstone, Ariz., and the 67-square-mile Alamogordo Creek Watershed near Santa Rosa, N. Mex. Three "record" storms of differing character occurring in 1960 and 1961 on Alamogordo Creek Watershed and one "record" storm in 1961 on the Walnut Gulch Watershed were analyzed and compared in detail.

Southwest Watershed Research Center, SWCRD, ARS, USDA, Tucson, Ariz., 85717

192. Marlatt, W., and Riehl, H. PRECIPITATION REGIMES OVER THE UPPER COLORADO RIVER. *J. Geophysical Res.* 68: 6447-6458. 1963.

Daily precipitation values recorded at weather stations in the Colorado River basin were summed with an area weighting method to yield a daily mean basin value to study certain aspects of the climatology of precipitation over the basin. Several checks were performed to test the reliability of the procedure.

A good correlation was obtained between computed annual precipitation and annual river discharge. Fifty percent of the annual precipitation was produced by 16 percent of the number of days having precipitation per year (about 260). A correlation existed between daily precipitation and the fraction of the area receiving precipitation, so that large amounts of basin-integrated precipitation were derived from widespread precipitation over the whole basin.

The variance of annual precipitation was caused by variation of the number of days having large amounts produced by passing synoptic-scale weather disturbances. The numerous days with precipitation less than 0.10 inch did not contribute to the variance and were reckoned as noise.

Seasonal variation of precipitation was small in comparison with the adjoining climatic regimes to the west and east. The constancy of the average course of precipitation through the year was ascribed to inverse variation of total moisture content of the atmosphere and of the intensity of dynamic factors producing vertical motions.

Colo. State U., Fort Collins, Colo.

193. Huff, F. A. ATMOSPHERIC MOISTURE-PRECIPITATION RELATIONS. J. Hydraul. Div., ASCE 89 (HY 6): 93-110. Nov. 1963.

Relationships were established between water vapor inflow, precipitable water depth, and surface precipitation, in Illinois, under average and extreme weather conditions. The water vapor inflow and precipitable water depth normally maximize in summer, but the percentage of the water vapor precipitated as rain or snow is greatest in the spring. Normally, nearly 50 percent of the water vapor is contained in the lower 5,000 ft.

Studies of severe rainstorms indicate that an extremely moist atmosphere is not necessary for the development of such storms, although the moisture inflow and concentration is usually above normal. The average precipitation efficiency in winter and summer storms was found to be nearly equal, with heavier summer rainstorms resulting from a greater inflow of water vapor.

Analyses of dry periods of 5 days or longer and of severe 12-month drought indicate no distinct trend for large departures from normal depths of precipitable water in such periods.

Ill. State Water Survey, Urbana, Ill.

194. van't Woudt, B. D. A PAN EVAPORIMETER FOR RAINY AREAS. Hawaii Agr. Expt. Sta. Tech. B. 57, 39 pp. 1963.

An evaporation pan, University of Hawaii (U.H. pan), was developed with a water level that remains at a constant level during both rainy and nonrainy periods. Records are obtained from reading a gage on the outside of a water supply tank holding 1 to 2 months' supply. A continuous evaporation record can be obtained by using a float recorder on the supply tank.

1. The record obtained with the U.H. pan during nonrainy periods was the same as that obtained by a U.S. Weather Bureau Class A (W.B.) pan. During rainy periods, the U.H. pan records approximately 6 percent lower evaporation than the W.B. pan. Under Hawaiian conditions, a pan intercepts some 5 percent less rain than a rain gage. Differences in amounts of rainfall intercepted by a pan and a rain gage may vary according to the circumstances under which the rain falls. Under Hawaiian conditions the U.H. pan records evaporation more accurately than the W.B. pan during rainy conditions.

2. An error is introduced in evaporation measurement by the U.H. pan during rainy periods, generally not exceeding 1 percent. A correction can readily be applied.
3. The U.H. pan can be used more conveniently than the W.B. pan for routine evaporation measurements, but one may expect, with normal care, to lose one record on 1 day in a year due to interference by dirt with the level-control mechanism. Inaccurate records may possibly be obtained when winds of over 40 miles per hour prevail.
4. But for the reservation mentioned under (3), the U.H. pan can be installed in isolated areas where only weekly attendance is possible.
5. The cost of manufacture of the U.H. pan was approximately $1\frac{1}{2}$ times that of the W.B. pan.

Hawaii Agr. Expt. Sta., U. Hawaii, Honolulu, Hawaii.

195. Egerszegi, S. DIE TIEFE BODENBEARBEITUNG IN UNGARN. Netherlands J. Agr. Sci. 11: 110-119. 1963. (From English Summary)

The variable weather conditions in the different agricultural districts of Hungary justifies attempts to raise water storage to use the natural rainfall. Methods to accomplish this were studied.

A suitable soil classification system was described to judge the applicability and the results of deep tillage and deepening of the plowed layer.

Aspects and possibilities of deep plowing with and without turning were discussed. In Hungary, deep plowing to 40 to 45 cm. (16 to 18 inches) was most economical on prairie loam soils. On originally alkaline soils with strongly alkalinized subsoils, yields increased in proportion to the depth of loosening, depending on the crop produced. This was also true for heavy meadow clay soils.

The methods of summer cultivation, developed in Hungary, to insure good tilth and to produce a good seedbed were discussed.

In sands, the deepening of the layer suitable for root growth and the principles of the amelioration in layers of sand soil were given. The methods applied and the results obtained were discussed. Deep tillage and deep placement of nutrients on blowing sands gave higher yields and a greater production security. Larger variety of crops were produced and irrigation requirements were reduced 25 to 35 percent.

Mimeographed English translation available from Tillage Laboratory, State Agr. U., Diedenweg 20, Wageningen, The Netherlands.

196. Lunin, J. AN ANNOTATED BIBLIOGRAPHY ON FREEZING AND THAWING OF SOILS. U.S. Dept. Agr., Agr. Res. Serv. ARS 41-74, 30 pp. 1963.

Much of the past work on freezing and thawing of soils has been done by investigators interested primarily in the engineering aspects. The subject is of great interest to soil scientists, because it is closely related to soil erosion, watershed hydrology, and drainage problems.

References and abstracts of the literature pertaining to freezing and thawing of soils were given for their potential application to the solution of agronomic problems. The investigations reported include many phases of the subject, ranging from the theoretical aspects to the more practical applications.

SWCRD ARS, USDA, Beltsville, Md., 20705

Surface Soil Removal

197. Moldenhauer, W. C., Maddy, J., Schmidt, B. L., and Shrader, W. D. ESTABLISHING VEGETATION ON EXPOSED SUBSOIL IN SOUTHERN IOWA AND NORTHERN MISSOURI. U.S. Dept. Agr., Agr. Res. Serv. Agr. Inform. B. 280, 15 pp. 1963.

Methods of establishing vegetation on exposed subsoil in southern Iowa and northern Missouri were described and illustrated. The following points were given:

1. A mulch is essential. Wheat straw is best. Oat straw is good. Manure is very good if slopes are not too steep. Anchor straw with a disk, if possible.
2. Fertilizer is essential on raw subsoil. Satisfy the lime requirement. Apply 25 pounds of nitrogen, 180 pounds of phosphate, and 120 pounds of potash per acre for grass-legume mixtures. This will last a few years. Apply 40 pounds of nitrogen and 100 pounds of phosphate for grass seedings alone. Fifty pounds of nitrogen per acre annually are needed for cover maintenance on grass seeded alone. Fertility requirements will be reduced if topsoil is replaced.
3. A bromegrass-tall fescue-alfalfa-red clover mixture is best. Seeding rates of 12 pounds of brome, 8 pounds of tall fescue, 6 pounds of alfalfa, and 2 pounds of red clover per acre are suggested as a grass-legume mixture. Be sure to inoculate legume seed. A bromegrass-tall fescue mixture seeded at the rates of 15 pounds of brome and 10 pounds of fescue per acre is suggested for grass seeded without legumes. Add 5 pounds per acre of Reed canarygrass on areas that may be wet for long periods. Birdsfoot trefoil at 6 pounds per acre may be used as the legume.
4. Seed in late March to early April or late August to early September. Don't seed after May 15 in the spring. Between May 15 and July 1 seed summer cover crops if absolutely necessary to control erosion. Sudan-grass is a good summer crop on raw subsoil.
5. Use mulch instead of a companion crop wherever possible. Where a mulch is not used, rye is a good companion crop on fall seedings. Oats do well where subsoil is mixed with topsoil and sufficient fertilizer is applied.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

Mulching

SEE ALSO 9, 62, 197.

198. Cahoon, G. A., Morton, E. S., Lee, B. W., and Goodall, G. E. THE USE OF PLASTIC GROUND COVERS IN CITRUS NURSERIES. Proc. Amer. Soc. Hort. Sci. 83: 309-315. 1963.

Various types and thicknesses of polyethylene and vinyl plastic sheets were placed on the soil around the base of citrus seedlings and budlings. Near the coast, using sweet orange rootstock, significant growth increases were obtained from all plastic treatments (black-white, natural, black, and aluminum polyethylene). Under similar climatic conditions, a significant growth response was obtained from black and clear vinyl plastic using Cleopatra mandarin as the rootstock. Further inland, plastic applications produced significant treatment differences on sweet orange but not on Troyer citrange or trifoliate orange. Black plastic controlled weed growth very effectively. Two plastics tested, natural and aluminum impregnated polyethylene, did not have sufficient durability or longevity for nursery use.

U. Calif. Citrus Res. Cent. and Agr. Col., Riverside, Calif.

199. Tukey, R. B., and Schoff, E. L. INFLUENCE OF DIFFERENT MULCHING MATERIALS UPON THE SOIL ENVIRONMENT. Proc. Amer. Soc. Hort. Sci. 82: 68-76. 1963.

Replicated mulch plots, 9 feet square, were established on a Tippecanoe sil soil at Lafayette, Ind. Eight mulches (peanut hulls, corn cobs, straw, sawdust, legume hay, granular foam rubber, glass-fiber, and gravel) were maintained to a depth of 6 inches for 5 years. Comparisons were made between soils under these mulches and corresponding soils under bluegrass sod and under clean cultivation.

The influence of these different mulches upon the soil were more alike than dissimilar. None of the mulches significantly influenced soil pH, the availability of Ca or Mg, the base exchange capacity of the soil, soil pore space, or the water holding capacity of the soil. Differences in soil micro-organisms were not consistent. All mulches increased the availability of soil P and K, soil moisture, and water penetration rate. All reduced soil temperature in the summer, soil aeration, and water evaporation. Differences between mulches were noted primarily in their influence upon the availability of K, the availability of P, and soil aeration. The latter two were associated with differences in texture of mulches. Soils under the fibrous materials, legume hay, straw, and glass-fiber were higher in available P and were better aerated. While K appeared more available under the more rapidly decomposable mulches, they were not significantly higher in available K than the others tested.

The lack of significant differences between the decomposing and nondecomposing mulches indicates that the primary effect of mulching is a physical effect upon the soil environment. Many of the differences which have been noted in plant performance when mulched with various materials may be the effect of the texture of the mulch rather than its rate of decomposition. Differences in soil aeration associated with texture were much greater than any differences that could be attributed to a differential supply of nutrients through leaching or decomposition of the mulch.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

200. Chepil, W. S., Woodruff, N. P., Siddoway, F. H., and Armbrust, D. V. MULCHES FOR WIND AND WATER EROSION CONTROL. U.S. Dept. Agr., Agr. Res. Serv. ARS 41-84, 23 pp. 1963.

Wind and water erosion have long been an agricultural concern. But military forces, highway departments, and industry also must combat this problem on bare soils resulting from various types of construction.

Procedures for establishing various kinds of protective mulch and for establishing and maintaining permanent vegetation were given. The word "mulch" means any substance, such as straw, hay, paper, gravel, organic or inorganic film, brush spread upon the ground, or produced and killed or allowed to die and left on the ground as a stubble mulch, or formed and left on the ground as a layer of clods or dust, for the purpose of protecting the soil from erosion or the plants from heat, cold, or drought. The term "permanent vegetation" means perennial vegetation such as grasses, shrubs, or trees growing on the land. Permanent vegetation is a living cover, whereas mulch is a dead cover. A mulch may be temporary such as dead vegetation, or permanent such as a layer of stones or gravel.

Information on stabilization of level and sloping ground was given.

A portable wind tunnel was used to determine the effectiveness of the various mulching treatments under field conditions. Limited information was obtained on the relative effectiveness of some of the treatments against erosion by water. From results of the wind tunnel tests, the wind erosion climatic factor and the universal wind erosion equation were

used to estimate the relative quantities of mulch required in various sections of the United States. An effective wind erosion control treatment was considered as one that will resist an 85-mile-per-hour wind as measured at 50-foot height.

SWRCD, ARS, USDA, Beltsville, Md., 20705

201. Lavee, S. THE EFFECT OF MULCH ON THE RESISTANCE OF E.M.-II APPLE STOCK TO SCLEROTIUM ROLFSII (SACC.). Proc. Amer. Soc. Hort. Sci. 82: 25-34. 1963.

A field survey and mulch experiments were conducted in Israel during 1954-57 in connection with the resistance of apple stock to Sclerotium rolfsii (Saac). Apple trees grown with clean cultivation were much more susceptible to the root rot fungus than those grown with natural or planted cover.

Mulch reduced soil temperature by as much as 11° C. at a depth of 5 cm. This temperature reduction was correlated with an increased development of a chemical substance (polyphenol) in the stem bark. Plants grown under mulch were twice as large as the controls. When soil temperature under mulch was artificially raised to the level of the unmulched control, plant development was similar to the controls.

Mortality of plants due to S. rolfsii was reduced by 50 percent in mulched plots although all plants were exposed individually to infection. The lower soil temperature in mulched plots was close to the thermal optimum for S. rolfsii development and most of the mulched plants were superficially attacked by the fungus. Mortality in the mulched-heated plots was similar to that in the unmulched control.

Natl. and U. Inst. Agr., Rehovoth, Israel.

202. Moody, J. E., Jones, J. N., Jr., and Lillard, J. H. INFLUENCE OF STRAW MULCH ON SOIL MOISTURE, SOIL TEMPERATURE AND THE GROWTH OF CORN. Soil Sci. Soc. Amer. Proc. 27: 700-703. 1963.

In a 3-year study, corn was grown on plots treated with 3 tons of wheat straw per acre, either placed on the surface or plowed under, and with two rates of N. Soil temperature, soil moisture, plant height and weight, N and K content of the plant and yields were obtained.

Soil temperature at the 4-inch depth was lower throughout the growing season under mulch conditions. The low temperature under mulch was associated with a temporary depression of growth during the early growing season. A significant increase in growth of mulched over unmulched corn, beginning in late June, was attributed to the greater moisture under mulch during the period of high plant requirements. Mulched corn was 64 cm. taller at tasseling and produced 42 bushels per acre more grain than corn which had the straw plowed down. Runoff was seven times greater from the unmulched plots.

Va. Agr. Expt. Sta., Blacksburg, Va.

203. Krueger, K. W. COMPOUNDS LEACHED FROM WESTERN REDCEDAR SHINGLE TOW FOUND TOXIC TO DOUGLAS-FIR SEEDLINGS. U.S. Forest Res. Note PNW-7, 6 pp. 1963.

Shingle tow, the stringy byproduct from the manufacture of western redcedar shingles, has been used for many years as packing material around roots of forest tree seedlings.

Ready availability, good moisture-holding capacity, and a tendency to retard mold development have made it popular in western nurseries. However, information from recent literature and preliminary test results indicate that compounds contained in shingle tow may be damaging to seedlings under some conditions.

Pathologists have credited decay resistance of western redcedar heartwood to presence of two groups of compounds, thujaplicins and polyhydric phenols.

High concentrations of thujaplicins were damaging to Douglas-fir seedlings. Further work is needed to fully determine the effects of low concentrations. Until a critical evaluation is available from work now in progress, it would seem advisable to substitute some other packing material for shingle tow.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

PLANT MANAGEMENT

Pasture and Haylands

SEE ALSO 6, 16, 51, 102, 104, 105, 120, 169, 173, 174, 175, 176, 190, 197, 215, 268, 269, 273.

204. Rogler, G. A., and Schaaf, H. M. GROWING RUSSIAN WILDRYE IN THE WESTERN STATES. U.S. Dept. Agr. L. 524, 8 pp. 1963.

A "culture and care" publication on growing Russian wildrye in the Western States was given.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

205. Beaty, E. R., Powell, J. D., Fortson, J. C., and Saunders, F. B. PRODUCTION ASPECTS OF A BEEF COW-CALF OPERATION ON GRASS PASTURES. J. Range Mangt. 16: 250-253. 1963.

Over a 7-year period, records were kept on a bermudagrass/bahiagrass-beef cow management unit at the Americus Plant Material Center. Costs of keeping a brood cow for a year and her calf until weaned were estimated to be \$73.87. Gross returns per calf were estimated to be \$100.32. Returns for investment, land, labor, and management were \$26.25 per cow year. The authors concluded that:

1. Better than a 90 percent calf crop was weaned (94 percent dropped) from a herd on a predominately grass ration that was adequate in quantity and supplemented with additional feed in the winter and minerals year long.
2. Year to year fluctuations in calf weaning weights were relatively small, the largest deviation being 6.42 percent.
3. Calves from 2-, 3-, and 4-year-old cows were well below herd average in size. Calves from cows 5 through 11 years of age were approximately 5 percent above average herd weight.
4. At weaning, heifer calves averaged 10.03 percent smaller than steer calves.

5. The average age at weaning for calves was 233 days and the adjusted weaning weight was 456 pounds. For each day over 233 days of age at weaning, calves, averaged 1.61 pounds heavier and for each day under 233 days they averaged 1.61 pounds less.

Col. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

206. Guenther, E. L. FORAGE CROPS FOR SOIL CONSERVATION IN HAWAII. J. Soil and Water Conserv. 18: 242-244. 1963.

In Hawaii, forage production is probably the best economic use for many large and remote areas, especially those on some of the steeper slopes. On these and other grazing lands, the goal is to provide adequate soil protection with plants that produce large quantities of nutritious and palatable forage under a wide variety of conditions of soil and climate. A number of plant materials have been developed for special soil protection purposes.

The perennial grasses most commonly used for grazing in the moist areas are pangola (Digitaria decumbens) and kikuyu (Pennisetum clandestinum). Guineagrass (Panicum maximum) is used chiefly at the lower elevations that seasonally become dry; buffelgrass (Pennisetum ciliare) is used under the driest conditions. Pangolagrass and kikuyugrass are propagated by vegetative means.

Suitable legumes are available for the moist sites and most of the coastal areas in Hawaii. Big trefoil (Lotus uliginosus) and kaimi clover (Desmodium canum) are the moist site materials; koa haole (Leucaena glauca) is adapted to many of the drier coastal areas.

Some well-managed koa haole paddocks produce in excess of 1,000 pounds of beef per acre. Koa haole tolerates the high lime soils along the coastline and will produce beef gains of over 500 pounds per acre per year on broken lava flows that are so rough they must be rolled before cattle can gain access to them. Whenever koa haole was included in Guineagrass ranges and pastures, substantial gains in beef production per acre were noted. Under certain conditions the mimosine content of this plant may be a problem. Intortum (Desmodium intortum) is a palatable, high-producing, viny legume with great potential for pastures in humid areas.

Other forage plants that are well adapted for special locations or uses include: Napiergrass (Pennisetum purpurem), which makes the best "green-chop" forage on cultivable lands; paragrass (Panicum purpurascens), which is excellent for use in swampy areas; and Rhodesgrass (Chloris gayana) and bermudagrass (Cynodon dactylon), which are salt tolerant and can provide cover on saline soils in coastal areas.

Fertilizers must be used to establish these plants and to obtain satisfactory production from them. Fertilizer needs vary with the great soils groups.

The plant materials center screens new plant materials and tests them under field conditions in cooperation with soil conservation districts. It also develops suitable methods for the production of improved plant species and varieties.

SCS, USDA, Honolulu, Hawaii.

207. Springfield, H. W. CATTLE GAINS AND PLANT RESPONSES FROM SPRING GRAZING ON CRESTED WHEATGRASS IN NORTHERN NEW MEXICO. U.S. Dept. Agr., Forest Serv. Prod. Res. Rpt. 74, 45 pp. 1963.

Crested wheatgrass was grazed at different intensities by cattle for a month-long spring season (May-June) from 1952-58 at one site and from 1955-58 at another site in

northern New Mexico. Cows and calves were used as test animals at one site and yearlings at the other.

Effects of the different intensities of grazing on crested wheatgrass stands and cattle gains were evaluated. Utilization of the wheatgrass averaged 41, 55, and 69 percent on three pastures for 7 years at one site, and 34, 56, and 77 percent for 3 pastures for 4 years at the other site. The utilization percentages were of the weight produced by the end of the grazing period; they did not include the regrowth that was made on all pastures after the cattle were removed.

Grass yields, stocking rates, plant heights, and cattle gains varied greatly from year to year in response to differences in precipitation.

Herbage production varied from less than 100 pounds per acre during a drought year to more than 800 pounds in a year of favorable moisture. No differences in crested wheatgrass yields resulted from the different grazing intensities.

Increasing the intensity of grazing resulted in greater fragmentation of crested wheatgrass plants, and a higher percentage of plants with three-fourths or more of the crown dead. Reproduction was sufficient to replace such plants under all intensities, except on the pasture grazed at an average of 77 percent.

Increasing the intensity of grazing also had a tendency to change crested wheatgrass from an erect to a spreading growth form. The proportion of plants producing culms, and the height of culms were not affected appreciably.

Litter accumulated under all grazing intensities, but the accumulation was less under all grazing intensities than where no grazing occurred. Litter accumulation was inversely related to grazing intensity.

Big sagebrush cover increased about the same under all intensities of grazing.

The advantages of crested wheatgrass for spring cattle grazing were shown by comparing daily weight gains from crested wheatgrass with nearby native range. Calves gained a pound more per day, and yearlings a half pound more, on crested wheatgrass grazed at the medium intensity compared with native range grazed at comparable intensity. Weight gains of the cattle grazed on the crested wheatgrass averaged 2 pounds or more a day.

Daily gains of cows were inversely related to intensity of grazing. Daily gains of calves and yearlings were not affected by the different grazing intensities.

Rates of stocking were largely dependent on amounts of herbage produced. Because of large differences in herbage production from year to year, considerable flexibility in herd management was necessary to make the most effective use of crested wheatgrass for spring grazing. The safest practice appears to be to start spring grazing when leaves of the grass are 4 to 5 inches long, then graze for 4 to 6 weeks or until the stand is properly utilized.

For a month-long spring season under New Mexico conditions, the optimum intensity of grazing appears to be 65 to 70 percent utilization by weight of the herbage produced by the end of the grazing period. Under this degree of use, the seeded stand was maintained in a productive condition and gains on calves and yearlings were satisfactory. Cows were affected by grazing intensity, but they made ample gains. Additional summer and fall growth usually helps maintain the vigor of plants heavily grazed in the spring.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Denver, Colo.

Rangelands

SEE ALSO 122, 131, 170, 206, 215, 263.

208. Neubauer, T. A. THE GRASSLANDS OF THE WEST. J. Range Mangt. 16(6): 327-332. 1963.

Of the 728 million acres of grazing land in the 17 Western States, about 407 million acres are privately owned pasture and range.

About 70 percent of this pasture and range is in land capability classes VI and VII. However, more than 72 million acres are in Classes I, II, and III, land suitable for the production of crops.

Erosion is the dominant problem on more than 217 million acres of pasture and range. Unfavorable soil is the dominant problem on 129 million acres.

About 307 million acres of the Western States' grassland needs conservation treatment. Establishment of the plant cover is needed on nearly 46 million acres, improvement of cover on about 84 million, and protection of the grass cover on nearly 178 million acres.

About 90 percent of the pasture and range (157 million acres) that need protection only is in an overgrazed condition. Nearly 69 million acres need protection from fire hazards. About 53 million acres of grassland need protection from woody and noxious plants as well as considerable acreage from erosion.

SCS, USDA, Washington, D.C. 20250

209. Reynolds, H. G. SELECTED BIBLIOGRAPHY ON RANGE RESEARCH IN ARIZONA. Ariz. Section Amer. Soc. Range Mangt. Proc. 1962: 50-68. 1962.

A bibliography on range research in Arizona was presented.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo., 80521

210. Woolfolk, E. J., and Reppert, J. N. THEN AND NOW: CHANGES IN CALIFORNIA ANNUAL-TYPE RANGE VEGETATION. U.S. Forest Serv. Res. Note PSW-N24. 9 pp. 1963.

Foothill grasslands and intermixed woodland areas compose California's largest and most important range type. For more than 300 years, livestock have grazed most of this 15- to 20-million-acre range.

Little is known of the nature or extent of these ranges in the beginning or even with the advent of livestock grazing. Even more meager is information on the effects of grazing and the changes in vegetation following use or such natural phenomena as fire, flood, and prolonged drought.

"Before" and "after" photographs (approximately 22 years) were given, showing: (1) The rapid increase of undesirable woody plants without fire or livestock grazing; (2) little change in woody plants with moderate to light (locally heavy) livestock grazing and no fire; and (3) deterioration of undesirable woody plants with moderate to close livestock use both with and without fire.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

210. Cook, C. W., and Stoddart, L. A. THE EFFECT OF INTENSITY AND SEASON OF USE ON THE VIGOR OF DESERT RANGE PLANTS. J. Range Mangt. 16(6): 315-317. 1963.

From 1955-61, research was conducted on typical desert range in west central Utah to determine the effect of intensity and season of use on the vigor of desert range plants.

Treatments in one phase included three intensities (25, 50 and 75 percent) and four seasons (fall, early winter, late winter, and spring). Treatments in a second phase included three intensities (30, 60, and 90) and four seasons (winter, early spring, late spring, and winter and late spring combination).

Ten plants of each of seven dominant desert species were chosen at two locations for phase one and at three locations for phase two. These were subjected to a schedule of clipping treatments for three successive years. Data were collected on reduction in live crown cover and percent of plants killed.

In the first phase, spring harvesting was the most detrimental and there was no significant difference among the fall, early winter, and late winter periods of harvesting. In the second phase, forage removal during the winter and again in late spring was the most detrimental. Late spring grazing was significantly more harmful than early spring.

Percent plants killed and reduction in crown cover increased with increased intensity of forage removal during all seasons for both phases of the study. This response to intensity was most apparent with late spring clipping.

It was concluded that desert ranges were best adapted to winter grazing and if used during this period would have about twice the grazing capacity as when grazed in the spring.

Utah State U., Logan, Utah.

212. Springfield, H. W. A SEEDING TEST WITH FOURWING SALT BUSH (CHAMIZA) IN WESTERN NEW MEXICO. U.S. Forest Serv. Res. Note RM-11, 11 pp. 1963.

Fourwing saltbush, generally called chamiza in New Mexico (Atriplex canescens (Pursh) Nutt.) is one of the most important and best known range shrubs in the Southwest. It provides forage the year round and is especially valuable as a source of energy and nutrients for livestock and game during winter and spring.

Seedbed preparation was necessary to obtain good stands of chamiza in western New Mexico. Although plants were successfully established by drilling or cultipacker-seeding on an unprepared seedbed, the resulting stands were much poorer than those on prepared seedbeds.

Under certain conditions, the seeding of chamiza on unprepared seedbeds could be a worthwhile practice. Many ranges in the Southwest support a satisfactory cover of herbaceous plants but no browse. On such ranges, particularly those reserved for winter grazing, drilling chamiza into the undisturbed herbaceous cover might result in a fair stand of browse needed to supplement the animal diet.

Of the methods of seedbed preparation tested, none proved definitely superior. Where the native cover is composed mainly of undesirable plants, plowing probably would be preferable. But where there is a remnant stand of desirable species, pitting is perhaps better than plowing since it damages only about a third of the native cover and is cheaper than plowing.

Neither of the two methods of seeding tested was found generally superior. Drilling was a better method for seeding unprepared or pitted seedbeds and cultipacker-seeding was better for seeding loose seedbeds.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo., 80521

213. Sanderson, H. R. Hubbard, R. L., and Seegrist, D. W. EFFECTS OF GRASS COMPETITION ON BITTERBRUSH: SECOND-YEAR REPORT. U.S. Forest Serv. Res. Note PSW-26, 7 pp. 1963.

The second year's data of a study designed to test the effects of perennial grass competition on the vigor of bitterbrush (Purshia tridentata) in an area of heavy bitterbrush mortality were given.

Competition from other plants, mainly perennial grasses, significantly reduced bitterbrush growth. The understory vegetation was not necessarily killing the bitterbrush but it was reducing growth and probably vigor, and perhaps making the plants more susceptible to damage from

other sources. If the lower vigor is linked to bitterbrush mortality, livestock and other deer management practices that favor browse over grass will have to be developed.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

214. Gary, H. L. ROOT DISTRIBUTION OF FIVE-STAMEN TAMARISK, SEEPWILLOW, AND ARROWWEED. *Forest Sci.* 9(3): 311-314. 1963.

Root system of three phreatophytes were excavated from alluvial banks near the Salt River in central Arizona. Tamarisk (Tamarix pentandra) roots occupied the capillary zone above the water table, with some roots in the zone of saturation. Seepwillow (Baccharis glutinosa) was shallow rooted, with branch roots in the first foot of soil profile. Arrowweed (Pluchea sericea) had a wide-spreading lateral-type root system.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

Plant Materials

SEE ALSO 51, 229, 231, 238, 239.

215. Lavin, F., and Pase, C. P. A COMPARISON OF 16 GRASSES AND FORBS FOR SEEDING CHAPARRAL BURNS. U.S. Forest Serv. Res. Note RM-6. 1963.

Sixteen species and varieties of grasses and forbs were test-planted on the Tonto National Forest after the Boulder Mountain fire of June 1959. This wildfire swept over 21,700 acres of steep, broken chaparral.

The species and varieties tested were divided into warm-weather and cool-weather growers on the basis of growth habit. The warm-weather growers consisted of: Caucasian, sand, Turkestan, King Ranch, and little bluestem; Lehmann, sand, and weeping lovegrass; switchgrass; and buffelgrass. The cool-weather growers were composed of: Cicer and sicklepod milkvetch; black and Indian mustard; a mixture of cold-hardy alfalfa varieties including Ladak; and Hardinggrass.

Lehmann lovegrass and King Ranch bluestem were the outstanding species with average ratings of excellent and good, respectively. Turkestan bluestem, weeping lovegrass, black mustard, and Indian mustard rated fair. Ratings of all other species and varieties ranged from poor to failure.

Buffelgrass at the start was the most vigorous species and rated excellent the first growing season but the stand died during the first winter. A poor stand composed entirely of new seedlings became established the second growing season but was killed during the second winter. During the third growing season only a few scattered buffelgrass seedlings were found.

Weeping lovegrass maintained a fair stand during the three growing seasons. At the last observation, numerous dead plants were found that apparently had been drought killed. Black and Indian mustard did not germinate and become established until the first winter after they were planted, but they maintained fair stands after that time. Poor stands of Caucasian bluestem, Cicer milkvetch, and sicklepod milkvetch maintained themselves. Poor initial stands of sand lovegrass, alfalfa, Hardinggrass, switchgrass, sand bluestem, and little bluestem died out before the end of the study.

Turkestan and King Ranch bluestem, black and Indian mustard, and Lehmann lovegrass all reproduced by natural reseeding.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

Woodlands

SEE ALSO 2, 11, 24, 25, 26, 121, 147, 161, 162, 203, 264, 265, 268, 269, 274, 275.

216. van Eck, W. A., and Whiteside, E. P. SITE EVALUATION STUDIES IN RED PINE PLANTATIONS IN MICHIGAN. *Soil Sci. Soc. Amer. Proc.* 27: 709-714. 1963.

Soil productivity for planted red pine in lower Michigan was evaluated for 27 soil series in terms of dominant tree height at age 50 by aid of local site curves developed from actual measurements.

In the presence of soil factors favoring adequate soil moisture supply and in the absence of soil factors which limited effective soil depth, the site index and growth rate of red pine was found to be rather uniform for many coarse- and moderately coarse-textured soils.

The inadequacy of a single set of site curves for the prediction of site productivity was discussed and separate sets of curves were presented for soils causing growth patterns deviating from the normal trend.

The observed variations in height growth were associated with even greater relative differences in volume of wood produced. While variations in the quality of the wood products are also important in evaluating the productivity of forest sites, this aspect was not covered in this study.

W. Va. U., Morgantown, W. Va.

217. Clutter, J. L. COMPATIBLE GROWTH AND YIELD MODELS FOR LOBLOLLY PINE. *Forest Sci.* 9(3): 354-371. 1963.

Past studies in loblolly pine mensuration have resulted in the development of numerous analytic models for growth and yield. Most have treated growth and yield as essentially independent phenomena with no attempt to develop models that possess the logical compatibility which must exist between growth and yield observations.

Models were developed to express realistically the relationships between growth and yield. As an initial step, previously used basal area and cubic-foot yield models were examined and screened for use. The yield models selected for use were differentiated with respect to age to produce models for cubic-foot and basal area growth.

The resulting growth models, together with the selected model for cubic-foot yield, were then fitted to data obtained in the 5-and-10-year remeasurements of 102 permanent sample plots located in three states. Equations were developed for cubic-foot yield, basal area growth, cubic-foot growth, basal area projection, and cubic-foot volume projection. Three of these equations can be used to predict total per acre production for various rotation ages and thinning regimes.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N. C.

218. Kozlowski, T. T., and Peterson, T. A. SEASONAL GROWTH OF DOMINANT, INTERMEDIATE, AND SUPPRESSED RED PINE TREES. *Bot. Gazette* 124: 146-154. 1962.

During 1960 and 1961, cambial growth was studied with vernier tree ring bands in a 34-year-old red pine (Pinus resinosa Ait.) stand in central Wisconsin. The seasonal rate of

cambial growth and time of initiation of cambial growth were studied for trees of dominant, intermediate, and suppressed crown classes. In addition, cambial growth in the upper stem was studied in dominant and intermediate trees for comparison with growth in the lower stem. The authors concluded that:

1. Dominant trees started growing earlier, grew faster, and had a longer growing season than intermediate trees. Suppressed trees grew negligibly and had a very short growing season.
2. Growth of all trees was highly intermittent throughout the growing season. Individual trees grew, stopped growing, then resumed growth. Growth cessation of some trees occurred even during the time when the average rate of growth for all trees was greatest. Seasonal growth patterns varied greatly during successive years, indicating extreme sensitivity of diameter growth to environmental stresses.
3. Growth inhibition in suppressed trees resulted from decreased rates of growth, shorter growing season, and later initiation of growth than in intermediate or dominant trees.
4. Trees grew faster in the upper than in the lower stem in both dominant and intermediate trees. At both heights, growth cessation and resumption occurred much more frequently in intermediate than in dominant trees.
5. Possible internal causes of growth intermittency were discussed. The delay in growth initiation of the more suppressed trees emphasized the importance of hormones in competition among trees.
6. Hydration effects on growth measurements of stems were discussed.

U. Wis., Madison, Wis.

219. Heinselman, M. L., and Roe, E. I. A RECORD OF SOME PLEISTOCENE TREES AND SHRUBS FROM ITASCA COUNTY, MINNESOTA. *Forest Sci.* 9(3): 336-337. 1963.

Slightly mineralized wood specimens found beneath about 100 feet of glacial drift in northern Minnesota proved more than 38,000 years old by carbon-14 dating. Present were Picea, Larix laricina, Abies balsamea, Pinus banksiana, Populus, Alnus, Vaccinium, and cones similar to Picea mariana, showing that the forests at that time were similar to those of today.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

220. Shipman, R. D. SEEDING DEPTH--ITS INFLUENCE ON ESTABLISHMENT OF DIRECT-SEEDED PINE IN THE SOUTH CAROLINA SANDHILLS. *J. Forestry* 61:907-912. 1963.

Field and greenhouse studies were undertaken in 1960 to determine the effects of seeding depth on the germination and establishment of direct-seeded longleaf and slash pines in the South Carolina Sandhills. Based upon data on seedling survival, optimum seeding depths were determined. Under field conditions, the recommended depth tolerance for longleaf pine was 1/4 to 3/4 inch, and for slash pine 1/2 to 3/4 inch. In the greenhouse, under a controlled environment, the optimum seeding depth for longleaf pine was between 1/8 and 1/2 inch, and for slash pine between 1/8 to 3/4 inch. Since the differences in optimum depths between the field and greenhouse trials can be attributed primarily to the added effects of seed displacement due to wind and water erosion, the field depths were recommended for Sandhill sites.

To improve seedling survival and to obtain adequate stocking, it was apparent that seed coverage is required when direct-seeding pine on cleared or furrowed sandy sites. Mechanical refinement of seeding machines to allow for correct seed placement is an important factor in achieving this objective. Seed of both species germinated more rapidly at the recommended depths of sowing and maintained this advantage at the termination of a 50-day growth period.

Pa. State U., University Park, Pa.

221. Dahms, W. G. DISPERSAL OF LODGEPOLE PINE SEED INTO CLEAR-CUT PATCHES. U.S. Forest Serv. Res. Note PNW-3, 7 pp. 1963.

In south-central Oregon, good crops of lodgepole pine seed are produced in most years. Natural regeneration of clear cuttings depends largely upon seeds dispersed from surrounding timber. Number of seeds dispersed into clear cuttings falls off very rapidly as distance from a timber border increases and reaches a very low level at distances beyond 200 feet. Foresters should restrict the width of clear-cut strips, patches, or blocks to 400 feet, if they plan to provide an ample seed supply for prompt natural regeneration.

Most of the current year's crop of seed was shed by November 1 and in some cases by early October. Seed-catch records indicated that seed dispersal from a western timber edge of a clear cutting was above average, while that from a southern timber edge was below average.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

222. Lockard, C. R., Putnam, J. A., and Carpenter, R. D. GRADE DEFECTS IN HARDWOOD TIMBER AND LOGS. U.S. Dept. Agr., Forest Serv. Agr. Hbk. 244, 39 pp. 1963.

There is a need for complete understanding of all factors affecting hardwood timber quality. Many appraisal problems formerly unimportant because of low stumpage values for generally high-quality timber have recently become pressing and formidable. There is widespread decrease in average level and increase in variability of hardwood timber quality. Perfect trees are rare; poor trees have become abundant. Volume per acre is lower and the trees are smaller.

Loggers especially are in dire need of a basic understanding of hardwood timber quality. Log making in high-priced timber of variable quality which fails to allow for and treat intelligently those factors affecting quality often results in material losses. The determination of the lower limit of log or tree merchantability becomes one of the most vital points. Merchantability of hardwood timber can no longer be judged simply on size, straightness, superficial smoothness, and freedom from rot and shake. It is equally influenced by type, location, and concentration of log defects, including many which are so inconspicuous as to be almost unnoticeable.

To utilize presently high-priced stumpage most profitably, it is increasingly necessary to prepare the harvest from a given hardwood stand for several markets rather than for only a single use. This means that the logging operation might produce veneer logs, factory lumber logs, logs for structural items, logs for low-grade construction lumber, stave bolts, dimension bolts, fence posts, pulpwood, charcoal or chemical wood, and fuelwood. An understanding of hardwood timber quality is essential for such multiproduct logging operations.

Another important need for definition of hardwood timber quality arises from the current widespread application of scientific forest management. A forester, marking timber must have a very thorough knowledge of the factors which govern quality.

FS, USDA, Inform. Div., Washington, D.C., 20250

223. Division of Forest Economics Research. **TIMBER TRENDS IN WESTERN OREGON AND WESTERN WASHINGTON.** U.S. Forest Serv. Res. Paper PNW-5, 154 pp. 1963.

Timber output in the Douglas-fir sub-region were assessed. An economic model was developed to account for the following major factors influencing timber output: Management practices followed on the forest lands; land use--the acreage and quality of land allocated to timber growing; and the time element as expressed in the guiding rate of return on forest investments.

Management intensity was classed as intensive (or conservative), intermediate, and extensive (exploitive). The conservative owners tend to hold relatively large investments in growing stock and their investments involve relatively low guiding rates of return. Exploitive-type owners make relatively small per acre investments and, in effect, have a high guiding rate of return. Determinants of guiding rates, such as availability of alternative investments, fringe benefits, risks and transfer costs, and characteristics of different owner classes were indicated.

The economic model was used to demonstrate the considerable influence that the interest cost of building up or holding of growing stock has upon total output, primarily through its effect on length of rotation. Management costs and timber revenues were examined with particular attention to the bearing of each determinant upon an owner's incentive to grow timber. Other factors such as regeneration costs, quality differentials, timber value trends, and costs of timber stand improvements and fertilization also were analyzed in terms of impacts on rotation age and on the total output that may be expected from various types of owners.

In order that potential timber output in the region could be estimated, the influence of land use and land ownership was considered. Currently, 73 percent (25.8 million acres) of the 35 million acres of land in the Douglas-fir sub-region is classed as commercial forest land, suitable and available for timber production. Under the land-use assumptions adopted, this will be reduced to 24.8 million acres by the year 2000. About half of this decrease of 1 million acres of commercial forest land is expected in public holdings and half in private. Large holdings are assumed to increase from about 5.4 million acres to 8.8 million. Medium-size holdings are assumed to drop from 1.7 million acres to 0.8 million. Small-size holdings are expected to drop from 6.1 million acres to 3.1 million.

After the various economic influences upon timber output and prospective land use were examined, estimates of the annual yields of timber that might economically be produced in the Douglas-fir sub-region in the long run were derived. For each class of owners--conservative, intermediate, or exploitive--guiding rates of return of 3, 6, and 12 percent, respectively were assigned. Economical per acre yields were estimated for each class of forest owner and for each forest type and site. The per acre yields estimated under the specified assumptions were then applied to the expected land use and forest ownership to estimate total annual yields in the long run. The effects of several alternative assumptions upon the longrun potential output were considered, including alternative price levels, interest rates, and land management and use.

The guiding rate of interest works upon potential output through the same influences as price and it also exerts an additional effect through its control over growing stock and rotation length. Various ways of reducing guiding rates of interest, such as transfers of ownership were indicated.

Consideration of alternative assumptions with regard to land use and management indicated that such changes that appear possible in the management of small holdings would not alter significantly the estimate of long-range timber output in the region.

The longrun potential of 13.1 billion board feet plus 400 million cubic feet per year was considered a destination or target.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

224. Gedney, D. R. TOWARD COMPLETE USE OF EASTERN OREGON'S FOREST RESOURCES. U.S. Forest Serv. Res. B. PNW-3, 71 pp. 1963.

During the decade of the 1950's, a reinventory of the forests of eastern Oregon was completed. This includes all the area east of the crest of the Cascades. The new estimate of the timber resources of the area adjusted to January 1, 1963, plus several supplementary studies of the forest industries, provides the foundation for the following conclusions:

1. Eastern Oregon contains $11\frac{1}{2}$ million acres of forest land capable of yielding repeated crops of timber products.
2. The 125 billion board feet of timber currently estimated to be growing on the commercial forest land is more than shown by any previous inventory.
3. Forest industries are a very important part of eastern Oregon's economy; in the future these and new forest industries will be the basis for much of its economic growth.
4. The manufacture of lumber is the major forest industry with 97 percent of all harvested logs processed in sawmills.
5. Eastern Oregon lumber serves distant markets and is facing increasingly strong competition from other products and other lumber-producing areas.
6. Future growth of the forest economy of eastern Oregon will necessitate the production of many kinds of usable products. This will require a forest industry capable of increased product refinement and diversity.
7. This growth will also depend upon an adequate source of raw material. Eastern Oregon now has such a source of raw material in its many species and sizes of trees.
8. Eastern Oregon forests can provide even more raw material in the future if a program of intensive management is undertaken. Such a program will require greater use of smaller size material and of secondary species.

Pacific Northwest Forest & Range Expt. Sta. FS, USDA, Portland, Oreg.

225. Driessche, R. van den. PARTIAL STERILIZATION OF DOUGLAS-FIR SEEDBEDS WITH FORMALIN AND CHLOROPICRIN. Forest Sci. 9(3): 330-334. 1963.

The two partial soil sterilants, chloropicrin and formalin, were used in an attempt to remedy fertility deterioration at two nurseries on the Vancouver Island, B. C. Both increased height growth and shoot dry weight of one-year-old Pseudotsuga menziesii seedlings at two nurseries, and seedling density at one. Chloropicrin treatments were more effective than formalin, and in two instances the high treatments of both were more effective than the low. Total dry weight production was almost doubled by chloropicrin at one nursery. Soil ammonia and seedling nitrogen content were increased by treatment, but

neither these increases, nor control of nematodes (which were rare), explained the response. Explanation in terms of control of fungi or change in several soil factors was suggested.

Dept. Botany, U. Col. Wales, Aberystwyth, U. K.

226. Boe, K. N. TRACTOR-LOGGING COSTS AND PRODUCTION IN OLD-GROWTH RED-WOOD. U.S. Forest Serv. Res. Paper PNW-8, 15 pp. 1963.

The cost to tractor-log old-growth redwood averaged \$12.24 per M. bd. ft. (gross Scribner log scale) loaded on trucks. Road development averaged an additional \$5.19 per M. bd. ft. These costs were based on 2 years of logging in a wide variety of terrain and timber during variable weather. They may be converted to a net log scale basis by dividing by the ratio of net log volume to gross volume of logs hauled.

The comparison between costs of logging on the three experimental cuttings showed that: (1) Costs were highest on the shelterwood; and (2) costs were lowest and about equal on the selection and clear cuttings. On all cuttings, the higher costs were associated with the smaller trees and logs. Since log volumes averaged the lowest on the shelterwood, costs were highest. Additional replications of the cuttings are needed to determine if log volume will continually average lowest on shelterwood.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

227. Forest Service. SPECIAL FOREST PRODUCTS FOR PROFIT; SELF-HELP SUGGESTIONS FOR RURAL AREAS DEVELOPMENT. U.S. Dept. Agr., Forest Serv. Agr. Inform. B. 278, 62 pp. 1963.

An "illustrative and descriptive" guide on special forest products for profit was given. FS, USDA, Inform. Div., Washington, D.C., 20250

Windbreaks

228. Shiflet, T. N. EARTHERN WINDBREAKS, A NEW MANAGEMENT DEVICE FOR SALT MARSH RANGELANDS. J. Range Mangt. 16(6): 332-333. 1963.

Earthern windbreaks provide cheap and effective protection for cattle against cold winds and driving rain or sleet on Louisiana marsh ranges during the winter months.

When properly located, windbreaks are an aid to distribution of livestock over the entire range. This results in better and more uniform utilization of the forage.

These earthern windbreaks can be tied into a system of cattle walkways on some marsh ranges making both facilities more valuable as range practices during the winter grazing season.

SCS, USDA, Lake Charles, La.

229. Howard, G. S., and Brown, G. B. SEVEN SPECIES OF BROADLEAF DECIDUOUS TREES FOR WINDBREAKS--EFFECT OF SPACING DISTANCE AND AGE ON THEIR SURVIVAL AND GROWTH AT CHEYENNE, WYO. U.S. Dept. Agr., Agr. Res. Serv. Tech. B. 1291, 16 pp. 1963.

Observations were made on spacing distances of seven species of deciduous trees for shelter-belts from their planting in 1932 until the experiment was terminated in 1957.

Siberian elm was the outstanding species of the dryland trees tested for shelterbelts, and wide spacing was superior to narrow spacing in giving maximum survival and growth. The 16- by 16-foot spacing distance gave the best survival for all species except honey-locust and Russian-olive, and the best growth for all. This distance should be interpreted as providing the best number of square feet of space per tree of the spacing distances tested and not the ideal arrangement for planting shelterbelt trees. None of the seven species in the test spread enough to grow together in the 16- by 16-foot spacing at 21 years of age; hence, they lacked density in the row. To have a species grow together in a row would require a spacing of perhaps from 6 to 10 feet in the row, depending upon the spread habit of the species. The rows should then be planted far enough apart to allot the desired number of square feet of space per tree. This wide spacing between rows would give the border-row benefits that were so noticeable in the experiment. The results of this study indicate the minimum planting distances shown in the table for best survival and growth.

Species	Spacing	
	In the row	Between rows
	Feet	Feet
American elm	8 to 10	20 to 25
Boxelder.	8 to 10	20 to 25
Green ash.	6 to 8	18 to 20
Hackberry.	6 to 8	18 to 20
Honeylocust.	8 to 10	20 to 25
Russian-olive	6 to 8	18 to 20
Siberian elm	10 to 12	20 to 25

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md.

230. Sander, D. H. HEIGHT-AGE CURVES FOR AUSTRIAN PINE IN WINDBREAKS ON LOESS SOILS OF NEBRASKA. U.S. Forest Serv. Res. Note RM-13, 2 pp. 1963.

Austrian pine (*Pinus nigra austriaca*, Schneid) is an important component of many Nebraska windbreaks. This species is relatively fast growing, provides good windbreak density in both summer and winter, and is relatively free of insects and diseases.

The heights that Austrian pines have attained at different ages on a range of sites, and a means of rating site capability or site quality were given.

Austrian pine grew rapidly during the first 20 years after planting--approximately 1 foot per year on the average site. The growth rate then decreased 0.025 foot per year on the average site, which resulted in a growth rate of only 0.2 to 0.3 foot per year 50 years after planting.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo., 80521

231. Phipps, H. M. THE ROLE OF 2,4-D IN THE APPEARANCE OF A LEAF BLIGHT OF SOME PLAINS TREE SPECIES. *Forest Sci.* 9(3): 283-288. 1963.

For several years a leaf blight of undetermined origin has appeared on *Acer negundo* L. and occasionally on several other tree species of the northern Great Plains. Growth loss and unsightly appearance have resulted in a decrease in the use of boxelder as a shelter-belt species. Several factors associated the blight with damage by 2,4-D--a herbicide used extensively as a crop spray applied both aerially and from the ground. A study involving the use of indicator plants sensitive to 2,4-D, root repression tests and chromatographic analysis of blighted foliage was undertaken to test this hypothesis. In addition, the sensitivity of boxelder foliage to be applied 2,4-D was tested and the very young leaf buds were found to be malformed by as little as .01 microgram. Results of all tests indicated that 2,4-D was the cause of the blight.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Management of Coffee Plantations

232. van Dierendonck, F. J. E. COFFEE PRODUCTION AND FERTILIZER TREATMENT. *Outlook Agr.* 4(1): 13-21. 1963.

Among the three major non-alcoholic beverages of civilized peoples, coffee is today the most widely enjoyed. Long before the plant came into cultivation, wild forest coffee furnished material for human consumption. Evidence of its use as a stimulant goes back to the time of the early Arab raids into Ethiopia, where the natives were found chewing the ripe or even dried fruits--a habit that persists in East Africa. From the practice of chewing dried seeds, that of brewing beverages from roasted beans was evolved by the Arabs about the middle of the fifteenth century.

Coffee holds a peculiar position in the world economy. Although it does not rank with cereals, sugar, oils and fats, and livestock products as a major agricultural crop, the proportion of its output entering international trade is greater than that for most other agricultural commodities. Coffee ranks next in value to petroleum in world trade.

The genus "Coffea" includes over 50 different species, and because of the great diversity of planting material can cover an extraordinarily wide geographical range. It extends beyond the two tropics, as in Brazil to the south, and Taiwan to the north, and is found at elevations ranging from slightly above sea-level to altitudes of 6,000 ft.

Among the numerous species few are important in commerce. The two most widely grown are C. arabica (Arabica) and C. canephora (Robusta). For commercial purposes three broad types can be distinguished: (1) Brazil's (Arabicas), (2) milds (Arabicas grown outside Brazil), and (3) Robusta, practically all of which comes from Africa and Asia.

A "culture and care" publication on coffee production was given.

Centre d'Etude de l'Azote, Geneva, Switzerland.

Fruit and Nut Crops

SEE ALSO 8, 43, 47, 85, 86, 94, 95, 97, 99, 100, 101, 108, 109, 110, 112, 125, 189, 198, 201.

233. Magness, J. R. ESTABLISHING AND MANAGING YOUNG APPLE ORCHARDS. U.S. Dept. Agr. Farm. B. 1897, 29 pp. Rev. 1962.

Apple trees have passed their greatest usefulness as commercial producers in most sections of the United States by the time they are 40 years old. As approximately 30 million bearing apple trees are required to produce a fruit crop of desirable size in the United States, about 10 million nonbearing or only slightly bearing trees under 10 years of age should be growing in this country to maintain the bearing acreage. A continuous development of new apple orchards is therefore desirable.

The selection of sites for the apple orchard, the planning and planting of the orchard, and soil management and pruning practices for trees up to bearing age were given. The basic principles discussed are applicable to conditions generally throughout the main apple-producing sections of the United States.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

234. Agricultural Research Service. GROWING BLACK WALNUTS FOR HOME USE. U.S. Dept. Agr. L. 525, 8 pp. 1963.

A "culture and care" publication on the growing of black walnuts was given.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

235. Edgerton, L. J., and Hoffman, M. B. INFLUENCE OF SOME GROWTH REGULATORS ON FRUIT SET IN THE MCINTOSH APPLE. Proc. Amer. Soc. Hort. Sci. 83: 63-67. 1963.

The effect of several growth regulators applied in the fall on fruit set and yield of McIntosh the following season was studied. Growth regulators used were NAA, 2,4,5-T, 2,4,5-TP, and 2,4-F.

A marked reduction in fruit set the following year occurred on the trees receiving the 2,4-F harvest spray. A slight reduction in fruit set occurred on trees sprayed with 2,4,5-TP, and a slight increase in set and yield occurred on trees receiving the 2,4,5-T harvest spray. Applications of 2,4,5-T at low concentrations in the spring during the pre-bloom stage also increased fruit set under certain conditions. At high concentrations, the spring application of 2,4,5-T reduced fruit set similar to the thinning action of NAA when applied as a post-bloom spray.

The addition of Tween 20 or oil increased the effect of both 2,4,5-TP and 2,4,5-T in controlling harvest drop and generally accentuated the effect of the auxin on fruit set the following spring.

The extent of this effect on fruit set and yield appears to be associated with pollination conditions during bloom as well as with the additive used at the time of application and other factors that may influence absorption of the growth regulators.

Cornell U., Ithaca, N.Y.

236. Proebsting, E. L., Jr. THE ROLE OF AIR TEMPERATURES AND BUD DEVELOPMENT IN DETERMINING HARDINESS OF DORMANT ELBERTA PEACH FRUIT BUDS. Proc. Amer. Soc. Hort. Sci. 83: 259-269. 1963.

Air temperatures during the dormant season affected hardiness of peach fruit buds in the Yakima Valley, of Washington. The relationship produced a significant correlation coefficient but was not close enough to be of value in estimating hardiness.

There was a minimum hardness level above which peach fruit bud hardness did not rise in spite of warm weather. This value was constant until the end of the rest period, then increased gradually as buds developed. The value differed from season to season. The beginning of microscope meiosis seemed to be a useful indicator for determining end of rest.

Hardening beyond the minimum hardness level occurred during periods when the temperature did not rise above 28° to 30° F. The duration of cold was more important than the degree of cold. If the temperature rose above 28° to 30° F., hardness was lost until it reached the minimum level. Loss of hardness can occur before the end of rest provided that hardness greater than the minimum level had been achieved previously.

The stage of bud development affected the minimum hardness level after the end of rest. As bud development progressed, the minimum level rose. Re-hardening capability was retained but appeared to occur less readily.

Irrig. Expt. Sta., Prosser, Wash.

237. Leyden, R. F., and Rohrbaugh, P. W. PROTECTION OF CITRUS TREES FROM COLD DAMAGE. Proc. Amer. Soc. Hort. Sci. 83: 344-351. 1963.

Cold protection investigations carried out near Weslaco, Tex., since 1955 were summarized as follows:

1. Wraps for citrus tree trunks, consisting of inert insulating material extending from the crotch to the ground and which can be left in place permanently, were shown in field studies and in controlled temperature cabinets to effectively insulate the trunk against cold damage.
2. Temperature inversions of from 3° to 10° F. existed between 1 and 28 ft. above ground on all nights of radiational cooling in the Weslaco area of the Lower Rio Grande Valley during the past 5 winters.
3. A single wind machine, located in the center of a 10-acre block, effectively raised the temperature over an area of from 3 to 10 acres during nights of radiational cooling.
4. Orchard heaters raised the temperature up to a radius of 20 ft. 2° to 4° F. on cold, calm nights. On cold, windy nights the effective radius was reduced to 10 ft. or less.
5. Minimum temperatures 1 and 5 ft. above ground, on nights of radiational cooling, were consistently higher over plots receiving the cultural practice of chemical weed control with no tillage than over sod culture or clean cultivated plots. Under windy conditions, these differences disappeared.

Tex. Col. Arts & Indus., Citrus Cent., Weslaco, Tex.

238. Young, R., and Olson, E. O. FREEZE INJURY TO CITRUS VARIETIES IN THE LOWER RIO GRANDE VALLEY OF TEXAS. Proc. Amer. Soc. Hort. Sci. 83: 333-336. 1963.

Trees of 23 citrus varieties in 3 scion trials and several single-scion orchards were examined following a severe freeze in January 1962 in the Rio Grande Valley of Texas.

Trees of Clementine and hybrid 6-5-15 mandarins and several sweet orange varieties were more cold hardy than grapefruit trees. Meyer lemon, Frost Eureka lemon, Mexican lime, and Dancy mandarin trees were cold sensitive.

CRD, ARS, USDA, Weslaco, Tex.

239. Young, R., and Olson, E. O. FREEZE INJURY TO CITRUS TREES ON VARIOUS ROOTSTOCKS IN THE LOWER RIO GRANDE VALLEY OF TEXAS. Proc. Amer. Soc. Hort. Sci. 83: 337-343. 1963.

Eight scion-rootstock orchards, including 71 different citrus cultivars as rootstocks, were exposed to a severe freeze in January 1962 in the Rio Grande Valley. Certain mandarin rootstocks induced more cold hardiness than other rootstocks when used for Meyer lemon, Valencia orange, Marrs orange, and Red Blush grapefruit trees. Trees on citrange, lime, and lemon rootstocks were generally more sensitive to cold injury than on sour orange rootstock.

Exocortis-virus-sensitive rootstocks (Rangpur mandarin-lime and Carrizo citrange) and xyloporosis-virus-sensitive rootstock (Columbia sweet lime) were injured to the same degree as virus-free trees on the same rootstocks. The recovery of trees on virus-sensitive rootstocks was poorer in the presence of the viruses.

CRD, ARS, USDA, Weslaco, Tex.

240. Snapp, O. I. INSECT PESTS OF THE PEACH: EAST OF THE ROCKY MOUNTAINS. U.S. Dept. Agr., Agr. Res. Serv., Agr. Inform. B. 272, 32 pp. 1963.

Peach trees and their fruit are attacked by many different insects and some mites. Among the most injurious pests are the plum curculio, peach tree borer, lesser peach tree borer, San Jose scale, oriental fruit moth, mites, and sucking bugs. These pests are responsible for much of the damage done to the trees and peaches in peach-growing regions east of the Rocky Mountains.

The biology and methods of control of each of these pests, and of other insects and mites that may cause serious damage were given. General recommendations for control were given. These may need to be modified or amplified to meet the needs of local areas.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

241. McElroy, R. C., and Powell, J. V. ECONOMIC ASPECTS OF PECAN PRODUCTION AND MARKETING: ARKANSAS, FLORIDA, GEORGIA, MISSISSIPPI, NEW MEXICO, AND SOUTH CAROLINA. U.S. Dept. Agr., Econ. Res. Serv., Agr. Econ. Rpt. 41, 41 pp. 1963.

Pecans are an important source of income to growers throughout the southern tier of States from North Carolina to New Mexico. The total crop of pecans consists of nuts from both seedling and improved pecan trees. The size of the crop varies widely from year to year. Quality varies among production areas in any given year and from year to year. Total production of pecans has trended upward and improved varieties are an increasing share of the total crop.

Production and marketing data obtained from pecan growers in Arkansas, Florida, Georgia, Mississippi, New Mexico, and South Carolina were given. Data were obtained from 576 pecan growers who owned 370,000 pecan trees, or 13 percent of the trees listed in the 1959 Census of Agriculture for the 6 states.

In 1961, 89 growers expressed intentions to plant over 38,000 trees, while 61 growers planned to remove about 4,000 trees. This would result in a 9 percent increase in the number of trees on the farms surveyed.

The most common cultural practice in pecan orchards was discing. Georgia growers disced 71 percent of the acreage, but the average for 5 States was 53 percent of the acreage surveyed. Removing dead and pruned wood was the second most important orchard practice, and was carried out on about 42 percent of the pecan acreage.

Information on insect and disease control practices was obtained from 359 producers who owned 25,000 acres of pecans. Of these, only 57 sprayed or dusted their trees; yet, these growers owned 43 percent of the acreage. Growers sprayed or dusted for aphids, scale, scab, nut casebearers, and caterpillar worms. Costs of material, per acre treated, ranged from \$2.30 in Florida to \$8.89 in New Mexico, and averaged \$7.26. These data are averages which include non-sprayed groves. Large commercial growers in the Southeast, where scab is a serious problem, report that spraying for scab costs approximately \$25 per acre.

Growers reported fertilizing almost 20,000 acres, or 78 percent of the survey acreage. Commercially mixed complete fertilizer was most commonly used in all States, except Mississippi where nitrogen fertilizers were used most.

Total man-hour requirements averaged 31.7 hours per acre and power-hour requirements averaged 4.3 hours. Of these, 7.2 man-hours and 2.4 power-hours were required for pre-harvest operations; and 24.5 man-hours and 1.9 power-hours were required for harvest operations.

Growers reported that 95 percent of their pecans were sold to dealers, 2 percent were still on hand at the time of the surveys, 1.5 percent were given away, 1 percent were sold retail, and 0.5 percent were used on the place of production.

The percentage of total farm incomes derived from sales of pecans varied widely, but did not average more than 50 percent in any state. In New Mexico, pecans accounted for nearly 40 percent of total farm incomes; South Carolina growers reported that pecans accounted for only 11 percent of total farm income.

Thirteen percent of the growers interviewed belonged to an association of pecan growers.

OMS, USDA, Inform. Div., Washington, D.C., 20250

Field Crops

SEE ALSO 17, 48, 49, 50, 54, 93, 106, 107, 113, 120, 122, 133, 134, 138, 139, 143, 152, 153, 154, 158, 159, 167, 168, 178, 179, 180, 181, 202, 246, 261, 268, 269, 277.

242. Miller, J. H., Kempen, H. M., Wilkerson, J. A., and Foy, C. L. RESPONSE OF COTTON TO 2,4-D AND RELATED PHENOXY HERBICIDES. U.S. Dept. Agr., Agr. Res. Serv. Tech. B. 1289, 28 pp. 1963.

The response of cotton to foliage applications of herbicides were: (1) Low rates of the ester formulations of 2,4-D, 2,4,5-T, 2-(2,4-DP), or silvex caused severe injury to cotton. The injury was correlated with the rate of application and decreased as the application date was delayed. (2) Among the herbicides, 2,4-D caused far greater damage to cotton than 2,4,5-T, 2-(2,4-DP), or silvex. Little difference, except in morphological malformation, was observed in cotton treated with the last three herbicides. (3) None of the herbicides at the rates used tended to increase yields of cotton. And (4) morphological malformations caused by the herbicides were dissimilar. The phenoxyacetic acid herbicides caused pronounced "strapping" of leaves and frequently caused proliferation of callous tissues in the root-stem transition zone of the plant. The phenoxypropionic acid herbicides caused "cupping" of the leaves and showed little tendency to cause proliferation of root-stem tissues. All herbicides retarded defoliation of the plants and caused malformed flowers.

The response of cotton to soil applications of herbicides were: (1) An alkanolamine salt formulation of 2,4-D, when used as sidedressed soil applications, caused greater damage to cotton than similar treatments with an alkanolamine salt formulation of MCPA. This was evidenced both by seed cotton yields and morphological abnormalities. And (2) neither 2,4-D nor MCPA at the rates used resulted in increased seed cotton yields.

The response of cotton to simulated drift rates of an alkanolamine salt formulation of 2,4-D were: (1) Cotton plants were damaged by an alkanolamine formulation of 2,4-D at rates as low as 0.01 pound per acre. (2) 2,4-D at concentrations that caused marked epinasty of cotton plants also reduced seed cotton yields. (3) Seed cotton yields were reduced most drastically by applications of 2,4-D at 0.1 and 0.01 pound per acre during the flowering and fruit-setting periods of plant development (June and July). Yields were also depressed by these rates of 2,4-D applied to cotton in early vegetative stages of growth, but some recovery occurred. Although the central axis of the plant was killed or greatly retarded, recovery was manifested in the development of lateral vegetative branches. A part of the 2,4-D may have been isolated and trapped in the dead tissues of the plant. (4) 2,4-D applied at 0.1 pound per acre after "cut-out" of the cotton plant reduced total yield. Vegetative growth for the most part had ceased and few epinastic responses were observed. The reduced yields were probably due to the arrested development of immature bolls. (5) Rates of 2,4-D as low as 0.01 pound per acre applied as foliar sprays on cotton retarded defoliation. And (6) foliar applications of 2,4-D varying from 0.1 to 0.00001 pound per acre on four different dates did not increase cotton yields.

The progeny response of cotton treated with herbicides were: (1) Cotton plants treated with low rates of 2,4-D produced seed of inferior quality; (2) the reduced quality was manifested by both reduced and delayed germination; (3) malformed first true leaves of progeny of plants treated with certain rates of 2,4-D showed that epinastic responses could be transmitted; and (4) the quality of seed from plants treated with 2,4-D was impaired markedly compared with seed from plants treated with MCPA.

The effect of herbicides on fiber quality of cotton were: (1) Fiber-quality data obtained on plants treated with soil applications of 2,4-D or MCPA failed to show any marked effects due to herbicide treatment. And (2) fiber quality was impaired by foliar applications of 2,4-D at 0.1 pound per acre. The reduced fiber quality was most marked with applications made in June and July. Little, if any, effect on fiber quality was observed when plants were treated at lower rates.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

Vegetable Crops

SEE ALSO 93, 111, 144, 146, 181.

243. Ounsworth, L. F. PRODUCTION OF SMALL POTATOES FOR WHOLE PACK CANNING. Amer. Potato J. 40: 430-434. 1963.

Potatoes were grown at spacing of 3, 6, and 9 inches, at rates of 800 and 1,600 pounds per acre of 5-10-15 fertilizer, with and without irrigation, and at early and late plantings. The purpose was to increase the yield of small, new potatoes for canning whole.

Planting at the 3- and 6-inch spacings outyielded the 9-inch planting in yield of potatoes of the 1 1/4 to 1 7/8 inch range. Spacing did not affect either the yield of No. 1 potatoes (over 1 7/8 inch) or the total solids content.

The double rate of fertilizer substantially reduced the yield of both small potatoes and No. 1 potatoes but did not affect the level of dry matter.

Irrigation tripled the yield of small potatoes, doubled the yield of No. 1 potatoes but had no influence on the total solids content.

Closer planting required a quantity of seed that was greater than the canning crop produced hence the production of small, new potatoes solely for canning whole was not an economically sound practice.

Canada Dept. Agr. Res. Sta., Harrow, Ontario, Canada

244. Waddington, J. T., and Teubner, F. G. THE CONCENTRATION OF TOMATO YIELDS FOR MECHANICAL HARVESTING WITH N-M-TOLYLPHTHALAMIC ACID. Proc. Amer. Soc. Hort. Sci. 83: 700-704. 1963.

The effect of N-m-tolylphthalamic acid on concentrating the yield of tomato for mechanical harvesting was studied. Applications at a concentration of 200 p.p.m. to young seedlings during development of the first inflorescence increased flower numbers and subsequent yields in a single harvest from 5 to 10 tons of marketable fruit per acre. Late-maturing indeterminate cultivars, however, failed to mature the increased crop of fruit before frost. The treatment was particularly successful with the dwarf determinate cultivar Epoch which has been specifically developed for use with mechanical harvesting equipment.

U. Nebr., Lincoln, Nebr.

245. Barnes, W. C., and Sitterly, W. R. CONTROL OF NUTSEDGE AND OTHER WEEDS IN VEGETABLE CROPS. Proc. Amer. Soc. Hort. Sci. 83: 728-733. 1963.

Purple and yellow nutsedge, as well as most other weeds, were effectively controlled in potatoes, beans, and corn with EPTC and in beans, corn, and tomatoes with PEBC. Broadcast applications were necessary for clean-up treatment but effective control was obtained by row treatment at about one fourth the cost. Soil moisture should be ideal for planting and the soil relatively free of undecayed crop refuse for best control. Incorporation was necessary. These chemicals injured crops other than those listed above unless applied 2 or 3 months before planting.

Clemson Col., Truck Expt. Sta., Charleston, S.C.

ECONOMIC AND SOCIAL ASPECTS OF SOIL CONSERVATION

Costs and Returns

SEE ALSO 205, 207, 222, 223, 224, 226, 227, 228, 241, 275.

246. Egbert, A. C., and Heady, E. O. REGIONAL ANALYSIS OF PRODUCTION ADJUSTMENTS IN THE MAJOR FIELD CROPS: HISTORICAL AND PROSPECTIVE (AN APPLICATION OF SPATIAL PROGRAMMING). U.S. Dept. Agr. Econ. Res. Serv. Tech. B. 1294, 67 pp. 1963.

An economic analysis of regional production adjustments that would maximize efficiency in the production of the major field crops--wheat, corn, oats, barley, grain sorghums,

soybeans, and cotton--consistent with the specific assumptions of the programing solution used were summarized. Analysis was made for two points in time--a recent past year, 1954, and a future year, 1965. The general objectives of the analysis were: (1) To measure the size of the production-consumption imbalance or adjustment gap under the regional production efficiency and other conditions of 1954; and (2) to estimate the prospective supply and demand balance in the crops considered under projected 1965 technology and conditions allowing for increased regional efficiency of production.

Except for soybeans, each of the seven crops considered in the analysis has been more or less under some continuous form of supply management since 1954.

The 122 major field crop producing regions were delineated in the United States. Linear programing was used to "specify" which of these regions could provide our needs of wheat, feed grains, cotton, and soybeans most efficiently. The efficiency criterion used was to meet national requirements at lowest total supply cost. Unit production costs were estimated for each cropping possibility within each region. These costs were estimated to reflect conditions of 1954 and 1965. Cost estimates for 1965 were simple projections of apparent trends of output and input. Estimated needs of 1954 were based on normal consumption rates and population, but not specifically related to prices. Projections for 1965 were based explicitly on estimated average national prices, population, and per capita income projections.

The basic bill of goods to be produced for 1954 was: Food wheat, 831 million bushels; feed grain, 3,977 million bushels of corn equivalent; oilmeal, 196 million hundred weight of soybean-oilmeal equivalent; and cotton, 12.2 million 500-pound gross weight bales. The projected bill of goods to be produced for 1965 was: Food wheat, 1,113 million bushels; feed grain, 5,338 million bushels; oilmeal, 316 million hundredweight; and cotton, 16.4 million bales--all units the same as above. This total bill of goods limited production nationally. Production was limited in each region by an estimate of the maximum total acreage available for growing wheat, feed grains, soybeans, and cotton.

OMS, USDA, Inform. Div., Washington, D.C., 20250

247. Henderson, H. A., Bell, F. F., and Cunningham, M. D. ECONOMICS OF FARMING SYSTEMS FOR CONSERVATION ON A LOW-PRODUCTION FARM IN THE UPPER EAST TENNESSEE VALLEY. Tenn. Agr. Expt. Sta. B. 362, 23 pp. 1963.

On a representative, low-production farm in the Upper East Tennessee Valley, estimated income would be increased considerably by use of improved farming systems involving more intensive soil management practices for conservation and higher levels of technology than now practiced, according to a budget analysis. Within the range of practices for conservation considered, the highest level did not result in the greatest income.

For the full-time farmer who has a high ratio of labor to other resources, the level of practices for conservation that the local SCS representative would ordinarily recommend would give a higher estimated income than either lower or higher levels as planned by him. This was true whether the income was measured by total receipts, family labor earnings, labor earnings per hour, or rate of return on capital.

For the part-time farmer who had more limited labor resources available for farming, and the same capital and land resources as the full-time farmer, the medium level of practices for conservation would give the greatest estimated total sales, greatest family labor earnings, and highest rate of return on investment if no charge were made for labor. The lower level of practices for conservation would give the highest return per hour of labor and the highest return to capital after paying for labor.

The following general relationship was suggested between the intensity of use of practices for conservation and current income: using practices more intensively raises the limit

on a farmer's current income if he has a low level of use, but as intensity increases beyond a certain level, benefits from their use decreases. The following corollary was given: there is an optimum economic level of use of practices from which either higher or lower levels of use will reduce possible current net income to the farmer.

Of the three levels of practices for conservation studied, neither the full-time farmer nor the part-time farmer would rationally select the highest level on the basis of current income alone. He would adopt the highest level only if he were willing to accept lower current income for an increased future income, if he were partly paid for the conservation practices, or if he were to receive some non-economic benefit such as an esthetic preference for the system.

The part-time farmer might rationally choose either the low-or medium-level of practices for a conservation system, depending on his own value system and economic status.

On the selected farm, the use of higher levels of practices for conservation would increase the total investment required and thus reduce the number of acres that could be operated with a limited amount of capital.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

Institutional, Educational, and Social Factors Affecting Conservation Application

SEE ALSO 14, 20, 21, 22, 206, 227, 247.

248. United States Department of Agriculture. RURAL RECREATION ENTERPRISES FOR PROFIT. U.S. Dept. Agr., Agr. Inform. B. 277, 43 pp. \$0.20. 1963.

Fun in the sun for the millions of city residents requires open space. Most outdoor leisure activities center around: Water sports, hunting, fishing, observing fish and wildlife, admiring scenery, and enjoying the natural rural landscape. The development of rural recreation resources is largely a matter of the use and management of land, water, plants, and wildlife.

Nearly three-fourths of the land and water in the United States is in private ownership. Some of the opportunities for income-producing recreation enterprises on this private land were described. The assistance available from the U.S. Department of Agriculture and other public agencies to develop the Nation's rural recreation resources was listed. In any locality, the many separate public services and individual enterprises can be combined into a substantial economic force through the USDA's Rural Area Development Program.

For sale--Supt. Doc., U.S. Govt. Printing Off., Washington, D.C.

249. Aines, R. O. RELEASE OF LAND FROM CONSERVATION RESERVE CONTRACTS: ADJUSTMENTS IN LAND USE; FARMERS' INTEREST IN NEW LAND-RETIREMENT CONTRACTS. U.S. Dept. Agr., Econ. Res. Serv., Agr. Econ. Rpt. 34, 18 pp. 1963.

The release of land from Conservation Reserve Contracts was studied by a national mail survey and farmer interviews in a 6-area survey.

The Conservation Reserve Program may be expected to result in considerable land use adjustment, with more adjustment taking place in areas with livestock than in cash crop farming areas. The farmers who planned to make a permanent land use adjustment from cultivated crops to grassland had land of lower value and lower yield. They planned to rent out more of their land, and planned to increase their livestock numbers more than the farmers who were returning their released land to cultivated crop production.

The major crop which farmers plan to produce on the released land is feed grains. Nearly half the land was used to produce feed grains before being put under contract, and

therefore retains its feed grain base upon release. A limited amount of the released land will be returned to wheat production. The return of the land to the production of feed grains and wheat will increase the total production of commodities already in surplus.

The release of land from conservation reserve contracts also will affect farm income. The effect on farmers' incomes will depend on whether the annual increase in income resulting from returning the land to production is greater or smaller than the annual conservation reserve payments received while the land was under contract.

It is difficult to draw conclusions concerning the kind of new land-retirement program that would attract the land which farmers plan to return to crop production, and yet would not offer excessive payments for land which farmers plan to leave in grass.

Perhaps the use of crop-restricting easements, purchased by giving farmers Government loans with variable rates of interest, is a method of limiting production that is worthy of further study. A schedule of loan rates could be developed to vary according to the quality of land and what land use adjustment was being made. The farmer would retain the prerogative of changing his land use at any time by repaying all or part of his loan and the interest, depending on the land use shift he desired to make.

The amount of money needed to finance the easement loans would be substantial.

AMS, USDA, Inform. Div., Washington, D.C., 20250

250. Brown, L. R. MAN LAND & FOOD: LOOKING AHEAD AT WORLD FOOD NEEDS.

U.S. Dept. Agr. Econ. Res. Serv., Foreign Agr. Econ. Rpt. 11, 153 pp. 1963.

The world food problem is closely associated with a rapidly developing population crisis. The food problem is two dimensional--a production problem and a distribution problem. Food supplies in the developed regions are abundant and steadily rising on a per capita basis. In the less developed regions, supplies are inadequate and although grain output per capita is now rising it is still below prewar.

The distribution aspects of the food problem give little evidence of immediate improvement. Population in the less developed regions, now totaling 2.1 billion, is expected to reach nearly 5 billion by the end of the century. If the expected addition of about 3 billion materializes, the less developed regions will need to develop an additional food production capacity equal to current world capacity.

Land, the most important ingredient in the agricultural production mix, is in limited supply. Of the earth's land surface of 33 billion acres, less than 3 billion acres actually produces crops in any given year. Ninety-three percent of this area produces edible crops; 71 percent of the total is used to produce grain. Much of the 7 percent in nonfood crops is planted to fibers, mostly cotton.

All of the world's seven geographic regions expanded grain output from 1934-38 to 1960-61. Not all regions, however, made per capita gains. The grain area expanded in all regions except North America and Western Europe where it declined 4 and 5 percent, respectively. The per capita grain area declined in each of the seven geographic regions.

Food consumption patterns vary widely between regions particularly where income variations are great. The share of total calorie intake deriving from the consumption of starchy food varies from 24 percent in North America to 74 percent in Asia. Comparable regional variations for livestock products range from a low of 4 percent in Asia to 35 percent in Oceania.

Man's principal sources of food energy are rice and wheat and supply 21 and 20 percent respectively of total calorie intake. All grains combined supply 53 percent of the total. Grains consumed indirectly in the form of meat, milk, eggs, and animal fat account for a substantial part of the remaining 47 percent.

The world trade pattern in all grains has changed drastically since prewar.

Projections of net regional grain trade flows show a growing dependence of all the current net importing regions on North America and Oceania. Net grain exports of North America are projected to 64 million tons in 1980 and 94 million tons in 2000.

It now appears that the U.S. agricultural sector is destined to play a leading role in future efforts to expand the world's food supply. The population/land relationship within a given country will influence production costs and should help determine the relative importance of direct food shipments versus the provision of capital and technical assistance needed to produce the additional food. Although the projected flow of food from North America to the less developed regions in future decades will be much larger than at present, it will be rather small when compared to the growing needs of these regions. Even so, this food will be strategically important in regions generally characterized by diets scarcely above the subsistence level.

OMS, USDA, Inform. Div., Washington, D.C., 20250

251. Larson, N. G. CONTRACT FARMING AND VERTICAL INTEGRATION 1953-1962 A LIST OF SELECTED REFERENCES. U.S. Dept. Agr., Natl. Agr. Libr., Libr. List 64 Rev., 77 pp. 1963.

This bibliography is a revision of U.S. Department of Agriculture Library List No. 64, issued in June 1958. Most of the items in the earlier list were incorporated into this new one and later publications have been added. The references cited were published for the most part, between January 1953 and December 1962. Because of the widespread interest in contract farming and vertical integration, many news items and unsigned articles of purely timely interest were listed along with those of more permanent value. The publications cited indicate opinions, trends, the nature and extent of contracting and integration, and changes in the organizational structure of agriculture in the United States. Some of the citations include both horizontal and vertical integration. References to integration in foreign countries may be found in the subject index under the names of the countries. Most of the items listed were annotated and all were classified by subject. An author index and a subject index were provided.

Natl. Agr. Library, U.S. Dept. Agr., Washington, D.C., 20250

BIOLOGY

Fish

SEE ALSO 14, 61.

252. Yashouv, A. INCREASING FISH PRODUCTION IN PONDS. Trans. Amer. Fisheries Soc. 92: 292-297. 1963.

Yields of carp (Cyprinus carpio) as high as 800-1,200 pounds per acre were secured when fish culture was initiated in Israel in 1938-39, but production has been increased threefold to fourfold in recent years. Good, rich, water quality and annual growing seasons of 270 days permit such yields. Biweekly fertilization to provide 2 p.p.m. nitrogen and 0.5 p.p.m. phosphorus increased carrying capacity fourfold, and daily production almost tenfold. Fertilization does not increase plankton biomass or fish production proportionately, nor does it maintain plankton at a constant high level of abundance. Increased rates of fertilization do not increase primary production over a level controlled by density-dependent factors.

Greater utilization of the productivity was secured by using carp and Tilapia nilotica, rather than just carp. Accumulation of metabolic wastes may be an important density-dependent factor controlling fish growth.

Fish Culture Expt. Sta., Dor, Israel

253. Welker, B. D. SUMMER FOOD HABITS OF YELLOW BASS AND BLACK BULLHEADS IN CLEAR LAKE. Iowa Acad. Sci. Proc. 69: 286-295. 1962.

Young yellow bass (Roccus mississippiensis) ate primarily entomostracans but started taking significant numbers of immature insects when the bass reached 50 mm., total length. Adult yellow bass showed little change in food habits with increase in size from 5 to 7.9 inches with immature insects and crustacea in 60 and 81 percent of the stomachs, respectively. Forage fish were found in 2 percent of the yellow bass in 1960, 24 percent in 1952, and 86 percent in 1943. Cladocera decreased in frequency in yellow bass stomachs from June to August, 1960. The highest frequencies of copepods, Hyalella, and immature insects occurred in July. The daily period of maximum feeding appeared to be 4 to 8 p.m. with maximum activity, as measured by gill net catches from 6 p.m. to 2 a.m. Black bullheads (Ictalurus melas) ate foods similar to the yellow bass except for a greater utilization of forage fish.

Iowa State Conserv. Comm., Onawa, Iowa

254. Lewis, W. M., Summerfelt, R. C., and Lopinot, A. RESULTS OF STOCKING CATCHABLE-SIZED WARMWATER FISHES IN A LAKE WITH AN ESTABLISHED FISH POPULATION. Trans. Amer. Fisheries Soc. 92: 235-238. 1963.

Three stockings of marked, catchable-sized, warmwater fishes were made in a 30-acre lake. Creel censuses were then conducted to determine the percent recapture of these fish and their contribution to the anglers' catches. The percent returns from the spring stockings during the year in which the fish were stocked were similar for the following three principal kinds of fishes: crappies, 32.0 percent; bullheads, 28.3 percent; and bluegill, 26.1 percent. Further returns from these stockings during the following year averaged only 2.5 percent. As compared to returns from the spring stockings, very poor returns resulted from a fall stocking subjected to fishing the following season. The overall return in this case was only 8.6 percent.

The contribution each kind of fish made to the anglers' catch of that fish varied with the density of the native population. Stocked crappies contributed 35.6 percent to the catch and bullheads 43.3 percent, while stocked bluegill contributed only 1.5 percent.

There was an unexpected increase in the catch of native fish in the year in which the stockings were made. The catch of native fish was 2,325 fish during the year prior to the stockings, 4,602 during the year of the stockings, and 2,835 during the year after.

Southern Ill. U., Carbondale, Ill.

255. Carufel, L. H. LIFE HISTORY OF SAUGERS IN GARRISON RESERVOIR. J. Wildlife Mangt. 27: 450-456. 1963.

Data from Garrison Reservoir and the tailrace area in north-central North Dakota revealed that sauger (Stizostedion canadense) growth rates were better than those reported for

other waters, with the exception of Fort Randall and Norris reservoirs. Garrison Reservoir saugers grew at a faster rate than those from the tailrace. Average calculated total lengths for saugers from Garrison Reservoir at annuli 1-6 were 4.9, 8.7, 12.3, 15.4, 18.4, and 23.1 inches, respectively whereas those from the tailrace at annuli 1-8 were 4.7, 8.5, 11.3, 13.8, 16.2, 18.7, 20.6, and 25.6 inches, respectively. The average number of eggs per pound of fish was 27,498. Females were more abundant than males, particularly in older age groups. Some male and female saugers mature at 3 years of age. Generally, spawning activities in the Garrison Reservoir and the tailrace take place between the first of May and the end of June.

N. Dak. Game and Fish Dept., Devils Lake, N. Dak.

256. Dahl, J. TRANSFORMATION OF IRON AND SULPHUR COMPOUNDS IN SOIL, AND ITS RELATION TO DANISH INLAND FISHERIES. *Trans. Amer. Fisheries Soc.* 92: 260-264. 1963.

Oxidation of pyrite exposed in lignite strip mining or in draining of peat bogs results in sulphuric acid and ferric sulphate, which cause fish kills when washed into streams, lakes, or ponds. Increased lignite mining and land reclamation in Denmark since 1940 have resulted in much fish kill and loss of fish habitat. For example, the bottom of the river Tim \ddot{a} is covered with precipitated ochre, and the deposits even extend into the estuary. The fish population of Søby Lake was killed by water from an abandoned mine. Slaked lime added to discharge water from mines may prevent damage, but drainage from peat bogs and abandoned mines is more difficult to control. Of 126 areas in the Varde a river system used for liberation of trout fry in 1939, 31 percent were abandoned by 1961 because of acid water and ochre from land reclamation projects.

Danish Inst. for Fisheries and Marine Res., Charlottenlund, Denmark

257. Walker, C. R. ENDOTHAL DERIVATIVES AS AQUATIC HERBICIDES IN FISHERY HABITATS. *Weeds*. 11: 226-232. 1963.

The disodium salt of 3,6-endoxohexahydrophthalic acid (disodium endothal) and the derivative identified by the manufacturer as the di-N,N'-dimethylcocoamine salt of endothal (TD-47) were particularly effective upon submersed species of aquatic vegetation as contact herbicides. Disodium endothal at concentrations of 0.5 to 10.0 p.p.m.w. was effective in controlling approximately 50 percent of the 19 species of plants involved in 270 tests. TD-47 at concentrations of 0.02 to 10.0 p.p.m.w. controlled 77 percent of the 11 plant species in 94 tests.

Algae (Chara, Cladophora, Pithophora, and Spirogyra) were more effectively controlled by TD-47 than by disodium endothal. Although TD-47 was at least 10 times more herbicidal than disodium endothal, it was about 100 times more toxic to fish. Disodium endothal was more than 50 percent effective on submersed aquatic plants at rates in excess of 2.5 p.p.m.w. with a wide margin of safety in fish (4- to 10-fold). Disodium endothal had a median tolerance limit ranging from 95 to 150 p.p.m.w. in the aggregate of nine fish species tested extensively. Median tolerance limits for TD-47 ranged from about 0.06 to 0.3 p.p.m.w. for five species of fish. TD-47 applied at a concentration lethal to fish (0.3 to 1.0 p.p.m.w.) was effective as a dual management tool in controlling vegetation and achieving partial or complete renovation of stunted fish populations.

Young, growing vegetation was most susceptible to control, and best results were achieved at water temperatures exceeding 60° F. Higher rates were required to kill plants as

they matured and stands became dense. Endothal liquid formulations were superior to granules in controlling algal mats, floating, and emergent plants. Granules were more effective on submersed rooted plants. TD-47 residues were of short duration. The rate of disappearance depended on time and concentration. Detectable residues disappeared within 8 days following application of 0.3 p.p.m.w. and within 2 weeks for 0.6 p.p.m.w. However, 1.0 to 3.0 p.p.m.w. took up to 25 days to disappear. Some residues were found in fish-food organisms from treated enclosures 3 weeks after application.

Fish Control Lab., Bureau Sport Fisheries, and Wildlife, La Crosse, Wis.

258. Bridges, W. R., Kallman, B. J., and Andrews, A. K. PERSISTENCE OF DDT AND ITS METABOLITES IN A FARM POND. Amer. Fisheries Soc. Trans. 92(4): 421-427. 1963.

A farm pond near Morrison, Colo., was treated with 0.02 p.p.m. of DDT in June 1961. The persistence and distribution of the insecticide in materials sampled from the aquatic environment were studied until November 1962. Detectable amounts of DDT were not found in the water after 3 weeks. Residues in the mud had declined within 8 weeks after the treatment to levels not significantly higher than pre-treatment levels, but a sample of vegetation still contained relatively high levels of residues. From this time until the second summer, sufficient vegetation was not present to provide a sample for chemical analysis. A new crop of vegetation sampled 1 year after the treatment contained residues approximating pre-treatment levels.

Fish accumulated 3 to 4 p.p.m. of DDT and its metabolites within 1 month after the treatment. The residue levels slowly declined after this, but when the study was terminated, 2 to 3 p.p.m. of the metabolites DDD and DDE still remained in the fish. The highest residue levels measured in crayfish were about one-half of those found in fish. Some mortality of the more susceptible fish and invertebrates occurred as a result of the DDT treatment; however, severe adverse effects were not demonstrated.

Bureau of Sport Fisheries and Wildlife, Fish Pesticide Res. Lab., Denver, Colo.

Upland Wildlife

SEE ALSO 14, 213.

259. Hennessy, T. E., and Van Camp, L. WINTERING MOURNING DOVES IN NORTHERN OHIO. J. Wildlife Mangt. 27: 367-373. 1963.

Wintering flocks of mourning doves (Zenaidura macroura) were studied in two northern Ohio counties. Flocks formed in late November or early December. Doves stayed in or near picked cornfields during daytime, feeding and loafing. Each flock preferred a particular cornfield. When snow covered their food, the doves resorted to farmsteads, feeding on stored and spilled grain. Night roosting was in evergreens, heavy brush, and on the ground. Flocks ranged in size from 2 or more than 200 doves and were relatively stable in size; large flocks broke up in mild weather. Banding returns, statewide to 1960 and from 35 Ottawa County recoveries through 1961-62, indicated these doves were part of a nonmigratory or sedentary Ohio population. Movements of 30 recovered doves averaged 1.1 miles.

Ohio Div. Wildlife, Akron, Ohio

260. Davison, V. E., and Sullivan, E. G. MOURNING DOVES' SELECTION OF FOODS. J. Wildlife Mangt. 27: 373-383. 1963.

A new method was described for determining the food preferences of mourning doves (*Zenaidura macroura*). Of more than 200 food items appraised, 64 were evaluated as choice, 20 as fair, and the others as uneaten or only tasted. The foods were provided separately and repeatedly, several at a time, in natural settings, to wild (unpenned) doves in Georgia and Mississippi. The doves were free to select among foods that were equally available. The 3-year study included all months of the year. Significant competition was evident between doves and other wildlife species at each location. Taste--rather than color, shape, size, or surface texture--determined the doves' preferences. Tasting behavior explained the frequent occurrence of trace items in stomach analyses. No seasonal preferences were evidenced. The doves did not learn to like any food that they at first found unattractive.

The method should be useful in studies of other wildlife species that eat seeds, acorns, nuts, berries, and other vegetable food items.

The diet of mourning doves is seeds. These birds eat no significant amounts of animal matter, green forage, fruits, or nuts.

Tables.

SCS, USDA, Athens, Ga.

261. Chambers, G. D. CORN A STAPLE FOOD OF DOVES WINTERING IN NORTHERN MISSOURI. J. Wildlife Mangt. 27: 486-488. 1963.

Crop contents of 132 mourning doves (*Zenaidura macroura*) wintering in northern Missouri showed the major importance of corn in their diet. Corn occurred in 94.7 percent of all crops and comprised 95.1 percent of food volume. It was the principal food during each winter month. Perhaps cultivated grains, when readily available, enable northern wintering doves to survive.

Corn, sorghum, sunflower, and ragweed seeds were the principle food items found.

Mo. Conserv. Comn., Columbia, Mo.

262. Aldrich, J. W. GEOGRAPHIC ORIENTATION OF AMERICAN TETRAONIDAE. J. Wildlife Mangt. 27(4): 529-545. 1963.

Differentiation of both species and genera within the grouse family (Tetraonidae) has been pronounced in North America. Each of its species has become adapted to specific types of habitat. These vary greatly, from arctic tundra to northern desert scrub and humid forest of both deciduous and coniferous types. All the species are racially variable in some degree, from the sage grouse (Centrocercus urophasianus), with 2 races, to the ruffed grouse (Bonasa umbellus), with 13. The races tend to be correlated with the ecological climax area in which they live. There are a few cases in which this correlation is not obvious and racial variation seems to be entirely the result of geographical isolation. The present status of grouse depends chiefly on the extent to which modification of required habitat has taken place; the greatest changes have occurred in the grasslands and the least in the arctic-alpine areas.

Bur. Sport Fisheries and Wildlife, Dept. Int., Washington, D.C.

263. Mussehl, T. W. BLUE GROUSE BROOD COVER SELECTION AND LAND-USE IMPLICATIONS. *J. Wildlife Mangt.* 27(4): 547-555. 1963.

Over 700 observations of blue grouse (*Dendragapus obscurus*) broods were made in three areas of Montana from 1957-62. These observations indicated that broods used areas with specific types of ground vegetation. Quantitative measurements of the characteristics of vegetation at 87 brood observation locations were obtained in 1960-62. These measurements indicated that broods used herbaceous cover with relatively consistent physical characteristics of height, canopy coverage, and plant interspersion. The importance of adequate herbaceous brood cover, consisting mainly of native bunchgrasses and associated forbs was significant, as the summer brood range of blue grouse often overlaps grazing areas of domestic stock and big game.

Mont. Fish and Game Dept., Hamilton, Mont.

264. Ammann, G. A. STATUS OF SPRUCE GROUSE IN MICHIGAN. *J. Wildlife Mangt.* 27(4): 591-593. 1963.

Spruce grouse (*Canachites canadensis*), though scarce, are holding their own in Michigan. They are more often associated with jack pine (*Pinus banksiana*) than with spruces (*Picea* spp.), usually with small clearings. Habitat can probably be managed to favor them if it becomes desirable or necessary.

Mich. Dept. Conserv., Lansing, Mich.

265. Jonkel, C. J., and Greer, K. R. FALL FOOD HABITS OF SPRUCE GROUSE IN NORTHWEST MONTANA. *J. Wildlife Mangt.* 27(4): 593-596. 1963.

Fifty-six crops of spruce grouse (*Canachites canadensis*) were collected during September and October of 1960-62. Microscopic analyses of the crops showed that needles of the western larch (*Larix occidentalis*) were the principal food during this period, but consumption of this item declined in October. Other important foods were needles of pine (*Pinus* spp.), Engelmann spruce (*Picea engelmanni*); and Rocky Mountain juniper (*Juniperus scopulorum*); white clover (*Trifolium repens*); fruits of huckleberry (*Vaccinium* spp.), snowberry (*Symporicarpos rivularis*), and white mandarin (*Streptopus amplexifolius*); and grasshoppers (*Orthoptera*).

Mont. Fish and Game Dept., Helena, Mont.

266. Boag, D. A. SIGNIFICANCE OF LOCATION, YEAR, SEX, AND AGE TO THE AUTUMN DIET OF BLUE GROUSE. *J. Wildlife Mangt.* 27(4): 555-562. 1963.

Analyses of the contents of 775 crops taken from blue grouse (*Dendragapus obscurus*) during September and October of 1958-61 in north-central Washington were presented for statistical comparisons. Based on the eight foods which appeared with greatest frequency and volume, these comparisons showed that autumn diets of this grouse varied significantly with: (1) Location; (2) year taken; and (3) age category. It was suggested that preference may largely determine the food of these grouse and that the resulting diet may have a bearing on reproductive performance.

Wash. State U., Pullman, Wash.

267. Stempel, M. E. BOBWHITE QUAIL, WINTER WEATHER AND AGRICULTURE. Iowa Acad. Sci. Proc. 69: 259-265. 1962.

Bobwhite quail are still found in most of their historic range which extends north into Minnesota. The best Iowa populations are in the three southern tiers of Iowa counties. Their peak abundance occurred before 1900. Long cold winters and deep snows usually decrease quail numbers. However, in the best brushy cover near grain fields, they have persisted in good numbers even through the bitter cold winters of 1912, 1936, and 1960. The 1960 winter losses were estimated at about 70 percent in scanty cover and about 10 percent in high quality cover.

Iowa Conserv. Comn., Des Moines, Iowa

268. Arner, D. H., and Davison, V. E. WILD TURKEYS ON SOUTHEASTERN FARMS AND WOODLANDS. U.S. Dept. Agr. L. 526, 8 pp. 1963.

In a natural woodland habitat, a flock of wild turkeys usually ranges over a tract of 5,000 to 10,000 acres. With dependable water sources, choice foods, and good roosting trees, a turkey flock can be maintained on tracts of 500 to 2,000 acres.

Methods that can be used to increase wild turkey production are: (1) Provide choice turkey foods by planting grasses, grains, and legumes in fields adjacent to woodlands; (2) increase food production in woodlands by controlled burning, chemical brush control, thinning trees, and scattered small openings and clearings; (3) save food-producing trees and shrubs from eradication; (4) provide reliable, year-round sources of drinking water; and (5) protect turkeys from excessive hunting, nesting disturbances, poultry diseases, and certain kinds of predators, especially free-ranging dogs.

ARS, USDA, Inform. Div., Rm 645A, FCB, Hyattsville, Md., 20781

269. Montgomery, G. G. NOCTURNAL MOVEMENTS AND ACTIVITY RHYTHMS OF WHITE-TAILED DEER. J. Wildlife Mangt. 27: 422-427. 1963.

The nocturnal movements and activity rhythms of white-tailed deer (Odocoileus virginianus) were studied during all months of 1958 by observing marked and unmarked deer on a 3,000 acre area in central Pennsylvania. Deer spent the days in wooded parts of the area, but began to move into open fields 1 or more hours before sunset in winter and during the hour of sunset in summer. Before bedding, they grazed in open fields for about 4 hours after sunset in winter and for 7-8 hours after sunset in summer. They usually bedded in fields near the lower limits of their ranges. Seasonal changes in timing of the peak of nocturnal bedding may have been related to seasonal changes in the time when the evening feeding period began. Deer usually moved back to the woods just before dawn.

Ill. Natural History Survey, Urbana, Ill.

270. Gruell, G. E., and Papez, N. J. MOVEMENTS OF MULE DEER IN NORTHEASTERN NEVADA. J. Wildlife Mangt. 27: 414-422. 1963.

The migratory habits of mule deer (Odocoileus hemionus) in typical basin-and-range country of northeastern Nevada were studied during 1955-60. In all, 789 deer were marked, 438 with bells, on 12 different winter ranges. Sightings and kill returns indicated that

individual deer tended to return each year to the same winter and summer ranges. Often, deer wintering together scattered widely to different summer ranges, and deer on a particular summer range often moved to widely separated winter ranges. Many migrating deer traveled far past potential destinations; some fall migrants bypassed winter ranges 5 or 10 miles distant, and moved 80 or 90 miles farther. Migrants from other ranges did the same, only in opposite directions, this forming a crisscross migration. There appeared to be little topographic orientation with respect to major drainages and mountain ranges. Management implications of the scattered, crisscross migrations were discussed.

U.S. Forest Service, Elko, Nev.

271. Ripley, T. H., and McClure, J. P. DEER BROWSE RESOURCES OF NORTH GEORGIA. U.S. Forest Serv. Res. B. SE-2, 20 pp. 1963.

A sample of 894 plots and 17,880 points taken on forest land in 21 counties of north Georgia in conjunction with a Forest Survey gave estimates of browse production. Quality estimates of browse weight, stratified by ownerships, forest types, stand size, and site provided basic management data.

Utilization was localized and confined largely to National Forest lands, where it ranged from 16.5 percent on preferred to 3.7 percent on stuffing species.

In north Georgia, an average of 36 pounds of browse forage was estimated, with 16 pounds from generally desirable browse plants and 20 pounds from plants providing emergency or stuffing foods. Of the major ownerships sampled, National Forests had less desirable forage (12 pounds) and more undesirable forage (25 pounds) than either private or other public lands, which had 19 and 22, and 17 and 18 pounds, respectively, for desirable and undesirable forage.

Examinations of site productivity and forest type showed generally better production on good sites in pine types. Stand size also affected forage conditions mainly in the pine types where best production was associated with small sawtimber.

For all lands, the average production of desirable forage on 39 acres can probably safely carry one deer if utilization is held to 40 percent. Requirements of 52 acres per deer would be liberal on National Forest lands, compared to 33 acres per deer on private lands. Reasonable consumption of emergency foods would reduce these acreage estimates substantially.

Management leading to increased pine production probably is not detrimental to forage supplies, especially if short rotations are used in conjunction with precommercial thinnings. Any cultural work aimed at increasing browse production apparently will be more beneficial on better sites.

Tables, graphs, and photographs.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

272. Packer, P. E. SOIL STABILITY REQUIREMENTS FOR THE GALLATIN ELK WINTER RANGE. J. Wildlife Mangt. 27: 401-410. 1963.

Winter range grazed by elk (Cervus canadensis) in the Gallatin River valley in Montana was studied: (1) To determine the effects, on plant cover and soil conditions, of seeding and

protection from elk grazing; and (2) to develop useful soil stabilization criteria for watershed protection. Plots were installed to measure ground cover density, soil bulk density, and soil eroded by high-intensity rainfall. Some plots were protected from elk use by fencing; others remained exposed. Some protected and unprotected plots were seeded to a mixture of grasses; others were not.

Some grazed and seeded plots exhibited and retained nearly pristine plant cover (average density 97 percent) and soil conditions because surrounding natural snowdrift areas had prevented their use by elk. From 1958 through 1960, ground cover density increased from 26 to 73 percent on protected and seeded plots; from 33 to 62 percent on protected plots having native cover; from 24 to 52 percent on grazed and seeded plots, principally by stooling of plants; and from 26 to 33 percent on grazed plots having native cover. From 1959-60, lowest bulk densities, 0.70 and 0.72, were found on the pristine plots. Bulk density on protected and seeded plots improved from 1.13 to 1.03; on protected plots having native cover from 1.19 to 1.16; and on the grazed and seeded plots, from 1.40 to 1.25. Grazed plots having native cover deteriorated from 1.27 to 1.32. During the summers of 1959 and 1960, under the impact of six rainstorms having maximum 5-minute rainfall intensities of from 0.80 to 1.80 inches per hour, the amount of the eroded soil on the plots increased rapidly as the ground cover density decreased below 70 percent and as the bulk density of the soil increased above 1.04 g./cc. Erosion increased with increased intensity of rainfall, accelerating most rapidly on sites having less than 70 percent ground cover.

The authors concluded that: (1) Protection from elk grazing followed by seeding effected plant cover and soil improvements on the experimental plots; (2) management objectives for restoring and maintaining soil stability on this elk winter range included ground cover densities of at least 70 percent and soil bulk densities no greater than 1.04 g./cc.; and (3) these objectives were expected to remain relatively stable even under the impact of higher rainfall intensities.

Intermountain Forest and Range Expt. Sta., FS, USDA, Ogden, Utah

273. Wright, V., and Otte, P. A CENTRAL IOWA PHEASANT NESTING STUDY, 1961. Iowa Acad. Sci. Proc. 69: 252-259. 1962.

A study of nesting success of pheasants (*Phasianus colchicus*) on three areas in central Iowa in 1961 showed that the peak nest establishment occurred between May 16 and May 30. Hatching success varied inversely with pheasant population density. Twenty-four of the 96 nests found hatched successfully. Roadsides sheltered the highest percentage of nests on a per acre basis (46 nests/100 acres), followed by hayfields (24 nests/100 acres), and oat-fields (4.7 nests/100 acres). Idle land and fence rows contained the fewest number of nests. Most nests were located in cover from 16 to 22 inches in height. No significant relationship was found between the height and/or density of cover and the success of the nests. Farm machinery operations, especially hay mowing, caused the greatest destruction of nests.

Iowa State U., Ames, Iowa

274. Reynolds, H. G. A WILDLIFE HABITAT RESEARCH PROGRAM FOR THE SOUTHWEST. Ariz.-N. Mex. Wildlife Soc. Proc. 2: 28-40. 1963.

In the Southwest, the Forest Service is beginning a limited research program on wildlife habitat management. Forest, woodland, and shrubland habitats are designated for investigation for deer and elk.

For priority habitats and species, studies are directed toward: (1) Determining basic habitat requirements; (2) game responses to timber, range, and watershed management activities; and (3) methods for modifying existing land use practices and instituting new practices of specific benefit to game.

Game production and harvest are intimately associated with vegetation management. Better wildlife habitat management should improve multiple and sustained use of wildlands in the Southwest.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

275. Gamble, H. B., and Bartoo, R. A. ECONOMIC RETURNS FROM TIMBER AND WILDLIFE ON NORTHEASTERN FARMLANDS. *J. Wildlife Mangt.* 27: 457-466. 1963.

A study of 18 farms in Sullivan County, Pennsylvania, in 1961, showed that net annual timber returns amounted to approximately \$330 per farm. This compares with annual returns of about \$257 per farm for farmers providing room and board for hunters, \$42 for farmers leasing hunting rights, and \$26 for those allowing fee hunting. While timber returned a gross of about \$5.24 per acre per year, returns from deer under total forest conditions averaged approximately 95 cents per acre per year. All forms of wildlife included, total wildlife returns to the county were approximately one-quarter that of timber. Deer and hunter damage costs of \$200 per farm per year stimulated an increase in gross revenue to the county of about \$546 per farm. In Sullivan County, private landowners have little economic justification for making expenditures towards the improvement of wildlife habitat or hunting opportunity. Resource allocation to privately owned forest land should be made to production of timber rather than of wildlife if the objective is profit maximization.

Pa. State U., University Park, Pa.

276. Driscoll, R. S. REPELLENTS REDUCE DEER BROWSING ON PONDEROSA PINE SEEDLINGS. *U.S. Forest Serv. Res. Note PNW-5*, 8 pp. 1963.

Deer browsing of ponderosa pine seedlings can be reduced by spraying with 10-percent solutions of either zinc dimethyldithiocarbamate cyclohexylamine complex (ZAC), tetramethylthiuram disulfide (TMTD), or copper omadine, each mixed with 10 percent acrylic resin adhesive (Rhoplex AC-33), 0.2 percent Methocel (a thickening agent), and 0.6 percent Hexadecanol-ethanol (a defoaming agent). Covering with brush also reduces browsing. ZAC provides the most effective protection on a year-round basis.

The spray treatment must be applied each year to provide protection to yearly growth. This should be done in the fall after current growth is completed and before deer concentrate in plantation areas. The number of years spray treatments must be carried out was not determined.

Seedling mortality was high (48 percent) during the 2-year study period. Death by causes other than recognizable animal damage accounted for most of the loss. Seasonal mortality was greatest during the summer.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Wetland Wildlife

SEE ALSO 14, 61, 62.

277. Glasgow, L. L., and Thomas, C. H. MANAGING RICE FIELDS FOR WATERFOWL. La. Agr. 6(3): 6-7. 1963.

About 75 percent of the 4.5 million waterfowl that winter annually in Louisiana are found in the marsh and in the adjacent rice growing region in the southwestern part of the state. Since this represents a large percentage of the wintering population of the Mississippi Flyway, southwest Louisiana is the most important wintering area for waterfowl on the Gulf Coast.

Many ducks and geese feed in the rice fields and fallow rice fields at night and return to the safety of the marsh during the day. Feeding in these fields is more common in years when waterfowl food and feeding conditions in the marsh have deteriorated and during the period when the waterfowl hunting season is closed. Food-habit studies have shown that in the rice-marsh transition zone shattered rice makes up 50 percent or more of the diet of some species of ducks.

TABLE 1.--Pounds per Acre and Per Cent Change of Six Major Waterfowl Foods In Harvested Rice Fields of Southwest Louisiana, 1958 and 1959

Species and year	Lbs./acre Oct. 22-Nov. 10	Lbs./acre Feb. 7-19	Per cent change Oct. to Feb.
Domestic rice			
1958	142.4	12.2	-91.4
1959	73.3	5.8	-92.1
Red rice			
1958	8.6	4.2	-51.2
1959	49.3	27.0	-45.2
Millet			
1958	14.9	15.0	+0.1
1959	29.2	26.4	-9.6
Signalgrass			
1958	3.0	1.2	-60.0
1959	6.9	1.0	-85.5
Brownseed paspalum			
1958	3.1	1.4	-54.8
1959	1.7	1.1	-35.3
Smartweed			
1958	0.9	0.5	-44.4
1959	2.7	2.2	-18.5
Total			
1958	172.9	34.5	-80.0
1959	163.3	63.5	-62.4

TABLE 2.--Pounds per Acre and Per Cent of Six Major Waterfowl Foods In Fallow Rice Fields of Southwest Louisiana, 1961-62

Species	Average lbs./acre Nov.	Average lbs./acre Feb.	Per cent change Nov.-Feb.
Millet	124.58	70.65	-43.28
Brownseed paspalum	92.87	62.40	-32.81
Fall panicum	49.39	29.64	-39.99
Smartweed	44.34	30.67	-35.39
Signalgrass	13.26	6.74	-49.18
Red rice	3.55	3.89	+8.74
Total	327.99	203.99	-38

Often practices carried out to benefit waterfowl, conflict with some other riceland uses. The following recommendations were made for landowners primarily interested in benefiting or hunting waterfowl:

1. Repair levees soon after rice harvest.
2. Flood fields a few inches deep to prevent loss of seeds to small birds and rodents. Flooding also delays germination. Flood fallow fields during summer droughts.

3. Permit rank vegetative cover to grow along fence rows and canal banks to shield field from outside disturbances.
4. Control grazing by domestic animals.
5. In applying insecticides and herbicides, do not exceed recommended dosages for control of insects and weeds. Most of the insecticides and herbicides are toxic to animal life such as worms, crayfish, snails, and other organisms that provide some waterfowl food.
6. Control gunning so that ducks are not continually driven out of fields. Maintain large area field for rest area.
7. Small grains can be grown for waterfowl in fallow fields. One of the more promising is brown top millet.
8. Plans for fall hunting or leasing should be made in the spring. All available waterfowl shooting lands in southwest Louisiana are leased. Because of the demand for such areas, any landowner having medium to good shooting can lease his land as a unit for the season or sell permits for daily shooting. An added recreation in nearly all moist fields is excellent snipe shooting.

La. State U., University Station, La.

278. Emerson, F. B., Jr. THE VASCULAR PLANTS OF SOME MARSHES CREATED FOR WILDLIFE IN SOUTHCENTRAL NEW YORK. N.Y. Fish and Game J. 9: 37-43. 1962.

A list of 139 species of naturally occurring vascular plants found growing in the water and on the moist soil about the margins of 23 wildlife marshes in New York, studied during the summer of 1960, was presented. The frequency of occurrence and abundance of each species were noted. The dominant aquatic plants and their importance were mentioned. Brief mention was made of the mesophytic species which populate the dikes of the marshes.

Dept. Conserv., Cornell U., Ithaca, N.Y.

279. Erickson, H. R. REPRODUCTION, GROWTH, AND MOVEMENT OF MUSKRATS IN-HABITING SMALL WATER AREAS IN NEW YORK STATE. N.Y. Fish and Game J. 10: 90-117. 1963.

Reproduction, growth, and movement activities of muskrats in 41 small water areas of central New York were studied the year around from February 1957 through July 1959. Information was secured from more than 700 muskrats, primarily through live-trapping. The onset of breeding was highly correlated with the beginning of spring movement. No indications of precocial breeding were present in 37 immature females examined in the fall. Two adult females, bred in captivity, produced litters of six and three young after gestation periods of 28 and 29 days, respectively. Adult females from the study area averaged approximately 6.3 young per litter and nearly 1.5 litters per year. The sex ratio in 174 nestlings was 105 males to 100 females; in 279 September-trapped immatures it was 118 to 100; in 228 adults trapped from July through October it was 93 to 100. The age ratio in 364 September-trapped muskrats was 328 young per 100 adults, or 5.9 young per adult female.

Fifty-three young muskrats were born and raised in captivity. Growth curves were plotted through 50 days of age. Growth rates of captive and wild litters were compared. Second-year adults, as a group, were much larger than first-year adults. Adult males generally were larger than adult females.

Movements of muskrats were studied during spring, summer, and fall periods. The spring movement was by far the most extensive and appeared to be triggered by the break up of ice on the ponds. Summer and fall movements occurred at a much lower intensity than spring movements.

Summer home ranges of adults were studied on a small marsh in 1958. Twenty-one adults were present. Home ranges of 10 males coincided with those of 10 females to such an extent that pairing was indicated. Home ranges averaged approximately 200 feet in diameter. The ranges of several "paired" adults overlapped slightly.

Dept. Conserv., Cornell U., Ithaca, N.Y.

280. Benson, D., and Foley, D. D. HATCHING DATES OF WATERFOWL IN NEW YORK. N.Y. State Fish and Game J. 9: 73-92. 1962.

Hatching dates were calculated for nearly 1,900 waterfowl broods observed while less than 3 weeks old. For the principal species, the hatching peaks were found to be: Black duck, mid-May through early June; mallard, late May through mid-June; wood duck, mid-May through late June; and blue-winged teal, early June. Within these ranges, hatching dates in a given year tended to be earliest in the lower Hudson Valley, followed by Long Island, the Erie-Ontario Lowland, the middle Hudson Valley, the Southern Tier, and the central Adirondacks in that order. Little difference were noted from year to year for the same species in the same area.

Supervising Wildlife Biol., N.Y. Conserv. Dept.

281. Hodgson, R. H., and Otto, N. E. PONDWEED GROWTH AND RESPONSE TO HERBICIDES UNDER CONTROLLED LIGHT AND TEMPERATURE. Weeds 11: 232-237. 1963.

Vegetative propagules of sago pondweed (Potamogeton pectinatus L.) and American pondweed (P. nodosus Poir.) grown under a 14-hr. photoperiod of light varying in chromatic composition produced plants with longer internodes and more extensive shoot and stolon development under red light than under blue. Pondweeds grown for 4 weeks under 25 to 400 ft.-c of light made progressively more growth at the higher light intensities. Plant weight, branch number, and stolon development increased while shoot length and shoot-root ration decreased with increased light. Pondweeds grown under each of 5 light intensities at temperatures of 60°, 70°, or 80° F. were treated with emulsified xylene or alkyl tolyl methyl trimethyl ammonium chloride. Pondweeds cultured at the higher light intensities and higher temperatures were progressively more injured. Injury from treatment with either herbicide increased with age and plant maturity from early vegetative to flower-bud stage. Equivalent injury was produced on plants of equivalent maturity regardless of chronological age. Pondweeds cultured under 400 ft.-c of light and a 14-hr. photoperiod required approximately 900 degree-days over a 49° F. threshold to reach flower-bud stage.

CRD, ARS, USDA, Denver, Colo.

SUPPLEMENT

Problems Indirectly Affecting the Applications of Soil and Water Conservation Practices

SEE ALSO 231, 257, 258, 276, 281.

282. Johansen, C. BEE POISONING: A HAZARD OF APPLYING AGRICULTURAL CHEMICALS. Wash. Agr. Expt. Sta., Sta. C. 356 Rev., 9 pp. 1963.

Bee poisoning has increased in importance with greater use of insecticides and other chemical materials on a wider range of crops during the last 15 years. At the same time, insect pollination of crops has become a more critical problem because intensive cultivation and use of insecticides are reducing the populations of wild bees. Growers are finding it necessary to rent honey bee colonies for pollination of an increasing variety of crops in order to obtain good yields.

Most bee poisoning occurs when: (1) Insecticides are applied to crops during the blooming period; (2) drift of toxic sprays or dusts onto adjoining crops which are in bloom; and (3) contamination of blooming cover crops while spraying an orchard.

Bees contact the insecticidal residues on the plants. They also may obtain the poison by drinking or contacting contaminated water on foliage or flowers. They may also collect contaminated pollen or nectar. Bees may actually collect insecticidal dusts along with pollen. Arsenical materials and Sevin are especially hazardous because they may be stored with pollen in the hive and later fed to developing brood. Hazardous amounts of insecticidal materials have not been found in honey.

Some important points concerning toxicity of insecticides to honey bees are:

1. Small-scale laboratory tests of toxicity to bees do not necessarily indicate a hazard in the field.
2. The effect on honey bees is not necessarily an accurate criterion for the poisoning hazard to various wild bees. Endrin usually has less than 2 hours residual toxicity to honey bees; greater than 3 hours to alkali bees; and greater than 24 hours to the leafcutting bee, Megachile rotundata.
3. Many of the organic phosphate insecticides are highly toxic to bees and cannot be applied safely to blooming crops. Most of the "chlordane-like" group of insecticides (Chlordane, Dieldrin, Aldrin, Heptachlor) and Lindane or BHC, tend to have a residual toxicity which is a hazard to bees.
4. Some of the inorganic compounds, especially the arsenicals, are very toxic and have a long residual action against honey bees.
5. Because of short residual activities, some organic phosphate materials such as TEPP, Trithion, Dibrom, Phostex, Dylox, Delnav, Korlan, and Menazon can be applied safely to blooming crops when the bees are not foraging.
6. Systemic insecticides, such as Phorate, Demeton (Systox), and Schradan, are a reduced hazard to bees because they are rapidly absorbed by the plants. Bees do not contact the poison if it is applied when they are not foraging.
7. DDT and similar chlorinated hydrocarbons (TDE, methoxychlor, Perthane) tend to be moderate in their toxicity when applied as sprays and can be used safely while bees are not foraging. Toxaphene, Thiodan, and Endrin also fall in this category.
8. One organic phosphate, Schradan, is low in toxicity to bees and can be applied safely at any time.
9. Some of the dinitro compounds (DN-111 and Karathane), the botanical materials (e.g. Pyrethrum, Nicotine, and Rotenone), and all of the specific miticides (e.g. Aramite, Ovex, and Kelthane), are relatively non-hazardous to bees.

10. None of the fungicidal materials tested appears to be hazardous to honey bees.
11. Although 2,4-D and related compounds are non-hazardous to bees, certain formulations or derivatives (notably alkanolamine salts and isopropylesters are toxic. Other kinds of weedicides tested are not harmful to bees.
12. Blossom thinning materials have been non-hazardous as used in the orchards of Washington.

Wash. Agr. Expt. Sta. Inst. of Agr. Sci., Wash. State U., Pullman, Wash.

283. Mateos, M., and Davidson, D. T. CEMENTITIOUS PROPERTIES OF SOME IOWA FLY ASHES WITHOUT LIME ADDITIVES. Iowa Acad. Sci. Proc. 69: 362-369. 1962.

Fly ash is a byproduct of power plants burning powdered coal. As defined in ASTM Designation C 379-56T, fly ash is" . . . the finely divided residue that results from the combustion of ground or powdered coal and is transported from the boiler by the flue gases."

The annual production of fly ash in the United States is over 10 million tons and that of Iowa is about 200,000 tons. Only a fraction of the material produced is utilized as a pozzolan in mass concrete, as an ingredient in the manufacture of bricks, as an admixture with lime in soil stabilization, etc.

Seven Iowa fly ashes were evaluated as a construction material for embankments. Test specimens were molded at optimum moisture content for standard AASHO density and moist cured at 71° F. for 28 and 120 days. Six of the fly ashes gave unconfined compressive strengths between 42 and 665 p.s.i. after 28 days curing plus one day immersion in water.

Test specimens were also steam cured in an autoclave to find a possible quick way to evaluate the strength producing characteristics of a fly ash. The strengths obtained after curing for one day in the autoclave gave an indication of the strengths that could be obtained at ordinary curing temperatures for longer periods.

X-ray diffraction patterns of the fly ashes were included. The peak show that the reactivity of the fly ashes without lime was related to the amount of free lime present in the fly ash.

The fly ashes tested could be used in the construction of embankments. Some of them developed enough strength to warrant their use in the construction of subbases and subgrades for roads. The low strengths obtained with some fly ashes may be improved, if needed, by the addition of lime.

Engin. Expt. Sta., Iowa State U., Ames, Iowa

284. Blew, J. O., and Kulp, J. W., Jr. COMPARISON OF WOOD PRESERVATIVES IN MISSISSIPPI POST STUDY (1963 PROGRESS REPORT). U.S. Forest Serv. Res. Note FPL-01, 22 pp. 1963.

Experimental untreated southern yellow pine posts installed from 1936-38 at the Harrison Experimental Forest, Saucier, Miss., had an average life of 3.3 years. Untreated longleaf pine posts installed in 1949 had an average life of 2.3 years, while those treated with a No. 2 fuel oil and with Wyoming residual petroleum oil have an estimated average life of 5 and 8 years, respectively. Of southern yellow pine posts installed from 1936-41, those treated with borax-boric acid have all failed with an average life of 10.6 years and those treated at the groundline and top with Osmoplastic have all failed after an average life of 11.2 years. Posts treated with the following preservatives and installed

from 1936-41 have had failures totaling 10 percent or less of the number installed and should last 39 years or longer on an average: Pentachlorophenol, 3 percent and 4.8 percent in crankcase oil;--copper sulfate and sodium arsenite applied by double diffusion; and zinc meta arsenite. Posts in test in 1936-41 treated with other preservatives have an estimated average life of 8 to 39 years.

Forest Products Lab., FS, USDA, Madison, Wis.

285. Rockey, J. W. FARMSTEAD SEWAGE AND REFUSE DISPOSAL. U.S. Dept. Agr., Agr. Res. Serv. Agr. Inform. B. 274, 25 pp. 1963.

A guide to the sanitary disposal of sewage and household-type refuse on the farm was given.

Disposal of wastes--particularly sewage--in built-up communities and suburban and resort areas, and at rural establishments serving the public involves the public health and, therefore, is usually subject to regulation by appropriate authorities. Before installing any disposal system in such an area, or in a rural nonfarm area where space for disposal may be limited to a building lot, get the advice of the local health officer.

The material presented may be accepted as a guide to safe practice for those farm locations having no specific code requirements.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

286. Eby, H. J. MANURE DISPOSAL LAGOONS. U.S. Dept. Agr., Agr. Res. Serv. ARS 42-75, 12 pp. 1963.

The results of observations of manure disposal lagoons in several Eastern and Mid-western States and in Canada were given and the available literature on the subject was reviewed. Each lagoon was visited once in the summer and once in the winter. One eastern lagoon has been under continuous observation for more than 2 years. A bibliography was given.

For best results in managing a lagoon, these procedures should be followed:

1. Do not permit bedding of any kind, burlap bags, paper, or any floating material to enter the lagoon. Floating material interferes with the surface absorption of oxygen, reduces the penetration of sunlight for algae growth, and is unsightly and difficult to decompose. This is particularly true of poultry feathers.
2. Load the lagoon regularly and uniformly for maximum efficiency. Irregular, heavy loadings may overload the lagoon and result in a period of stagnation or may change it from an aerobic lagoon to an anaerobic lagoon.
3. Maintain a constant water depth.
4. Keep weeds mowed around the edges of the lagoon.
5. Fill the lagoon before running manures into it.
6. Agitate the surface with boards or an outboard motor if algae mats form on the surface. This will break up and sink the mats.
7. Do not allow petroleum products or other floating liquids to enter the lagoon.

AERD, ARS, USDA, Beltsville, Md., 20705

Radioactive Fallout

287. Reiter, E. R. A CASE STUDY OF RADIOACTIVE FALLOUT. Colo. State U., Dept. Atmospheric Sci. Tech. Paper 42, 35 pp. 1963.

During September 1961, a series of balloon ascents made from Flin Flon, Canada, carrying scintillation counters sensitive to gamma radiation, revealed the existence of shallow stable atmospheric layers carrying radioactive debris, presumably from the Russian test series during the same month.

The debris layers encountered on September 14 and 15 were studied in particular. The debris detected over Flin Flon on September 14, 2221 GCT, at 650 mb had undergone strong sinking motion. It was concluded that it came out of the stratosphere shortly prior to September 13, 12 GCT, entering the troposphere through the stable layer underneath the jet core, sometimes referred to as "jet-stream front".

Beginning with September 17, a distinct area of radioactive fallout began to appear at the surface over the eastern United States. Some of this debris seemed to be identical with the one detected over Flin Flon, and it apparently was transported by the same jet stream. Part of the fallout was associated with a small collapsing cold dome travelling ahead of this jet stream.

Colo. State U., Fort Collins, Colo.

288. Agricultural Research Service. USDA RADIOLOGICAL MONITORING HANDBOOK. U.S. Dept. Agr., Agr. Res. Serv., Agr. Hbk. 246, 44 pp. 1963.

Radiological monitoring includes identifying radiation, measuring its intensities, interpreting radiological data, and helping to develop defense plans that will prevent or alleviate damage and injury from excessive radiation.

This handbook provides radiological monitors of the U.S. Department of Agriculture with information, procedures, and guidance in conducting emergency monitoring services.

The levels of radiation intensity and radio-active contamination associated with fallout from nuclear weapons testing are relatively low--so low, in fact, that civil defense instruments now available for this monitoring are unable to measure accurately the resulting degree of contamination.

This Handbook supersedes unnumbered publication, USDA Radiological Monitoring Program, May 1961.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

289. Mayberry, B. D. SOME FACTORS INFLUENCING THE ABSORPTION AND TRANSLOCATION OF STRONTIUM BY PLANTS. Proc. Amer. Soc. Hort. Sci. 82: 614-618. 1963.

An investigation of the influence of Ca level and soil type on the absorption and translocation of Sr by the roots and the foliage, mainly of the lima bean plant, was conducted.

The roots of plants grown in commercial sand absorbed and translocated considerably more Sr than those in Norfolk sl and Bibb fs soils. The least amounts were absorbed from Bibb fs.

The reduction was greatest when Ca was applied at the rate of 1500 lbs./A. Addition of Ca above this level caused further reduction in Sr absorption, but at a slower rate. In all

treatments, Sr absorbed by the roots was readily translocated to the aerial portion of the plants. In no case, however, was the amount translocated more than 0.15 percent of the total amount applied to the soil.

Basipetal translocation of the foliar applied Sr did not occur in the lima bean plant.

Tuskegee Inst., Tuskegee, Ala.

290. Mortensen, J. L., and Marcusiu, E. C. FISSION PRODUCT-SOIL ORGANIC MATTER COMPLEXES: I. STRONTIUM-90 (YTTRIUM-90) IN WATER EXTRACTS AND HC1 HYDROLYSATES OF SOIL. *Soil Sci. Soc. Amer. Proc.* 27: 653-656. 1963.

Brookston soil was incubated with 40 μ c. Sr-90(Y-90) for 60 days and extracted with hot water or hydrolyzed with 6N HC1. The supernatant liquid was centrifuged, concentrated, and subjected to electrodialysis, dialysis, gel filtration, and paper electrophoresis.

Some Sr-90(Y-90) and organic matter migrated to the anode compartment during electrodialysis suggesting the presence of low molecular weight, negatively charged Sr-90 (Y-90)--organic matter complexes. Dialysis did not remove all of the Sr-90(Y-90) from the extracts.

Gel filtration separated the extracts into several organic matter containing components and showed that Sr-90(Y-90) was complexed or held on exchange sites by high molecular weight polymers. Presence of radioactivity in the components was correlated with the presence of polyuronides.

Phenols, α -amino acids and α -keto acids were separated from the 6N HC1 hydrolysate by paper electrophoresis but no clear correlation between these components and radioactivity on the paper strips was obtained.

Ohio Agr. Expt. Sta. Ohio State U., Wooster, Ohio

291. Polyakov, U. A., Leont'yev, A. M., and Mel'nikov, L. K. CERTAIN ASPECTS OF Sr⁹⁰ FALLOUT IN THE MIDDLE LATITUDES OF THE USSR. *Soviet Soil Sci.* 11: 1256-1259. Nov. 1962.

Three years of observations (1959-61) in Russia on Sr-90 accumulation by mosses and lichens have shown that these plants have a high capture energy for decay products and can be used as sources for determining Sr-90 radiation levels.

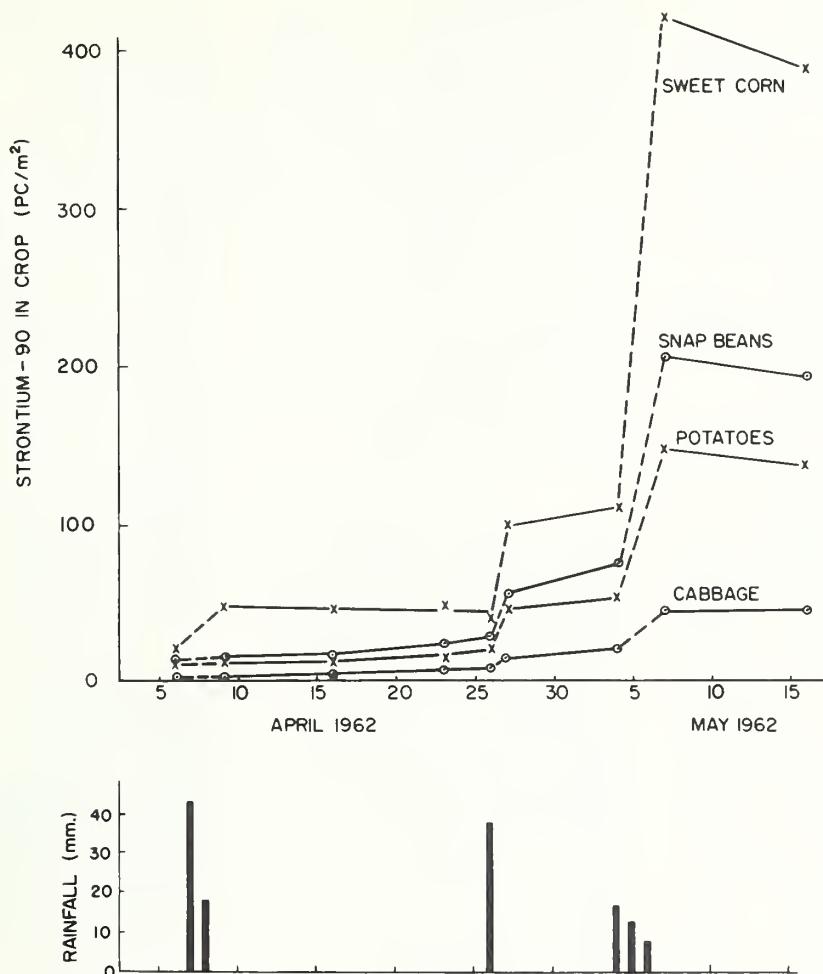
Depending on the species characteristics of the plant and the physical-geographic conditions of the environment, the accumulation of Sr-90 fluctuated within limits of 1564-6357 strontium units. There was a tendency towards increased accumulation of Sr-90 in 1960 compared with 1959.

Scripta Technica Inc., 1000 Vermont Ave. N.W., Washington, D.C., 20005

292. Menzel, R. G., Roberts, H., Jr., Stewart, E. H., and MacKenzie, A. J. STRONTIUM-90 ACCUMULATION ON PLANT FOLIAGE DURING RAINFALL. *Sci.* 142(3592): 576-577. Nov. 1, 1963.

Accumulation of strontium-90 in field-grown crops was measured during the spring of 1962. Each rainfall markedly increased the strontium-90 content of the crops, except when

the plants were very small. Accumulation between rains was comparatively small, about equal to the expected uptake from the soil.



Strontium-90 content in four crops grown at Belle Glade, Florida, in relation to date and amount of rainfall.

SWCRD, ARS, USDA, Beltsville, Md., 20705

INDEX TO AUTHORS

(Figures refer to article numbers)

Abdalla, A. A., 72
Abraham, T. P., 152
Achtermann, A., 16
Agricultural Research Service, 234, 288
Aines, R. O., 249
Aldrich, J. W., 262
Alexiadis, C. A., 66
Allaway, W. H., 98, 105
Allison, F. E., 87
Allmares, R. R., 145
Amemiya, M., 145
Ammann, G. A., 264
Amundson, A. J., Jr., 8
Anderson, D. M., 78
Anderson, H. W., 26
Andrew, L. E., 124
Andrews, A. K., 258
Armbrust, D. V., 200
Armson, K. A., 147
Arner, D. H., 268
Austin, W. G. L., 61
Awad, M. M., 101

Babcock, K. L., 184
Bajpai, P. D., 166
Ballinger, W. E., 47, 112
Bannister, S., 6
Barker, M. G., 146
Barnes, W. C., 245
Bartoo, R. A., 275
Baweja, A. S., 151
Beaty, E. R., 205
Bell, F. F., 247
Benson, D., 280
Benson, N. R., 94
Bergen, J. D., 39
Bidwell, O. W., 127
Biggar, J. W., 76
Biswas, T. D., 169
Blake, G. R., 140
Blew, J. O., 284
Blocker, W., 29
Boa, W. 55
Boag, D. A., 266
Boawn, L. C., 96
Bobritskaya, M. A., 89
Boe, K. N., 226

Boekel, P., 63
Bolt, G. H., 79
Bowden, K. L., 2
Bower, C. A., 183
Bower, D., 29
Brakensiek, D. L., 33
Bridges, W. R., 258
Brown, G. B., 229
Brown, J. C., 83
Brown, L. R., 250
Brown, N. J., 144
Brown, W. J., 7
Bruns, V. F., 60
Buras, N., 38
Burnett, E., 64, 122
Burwell, R. E., 145

Cahoon, G. A., 198
Carpenter, R. D., 222
Carter, D. L., 190
Carufel, L. H., 255
Cary, E. E., 113
Chambers, G. D., 261
Chennault, W., 94
Chepil, W. S., 122, 200
Chmelir, I. C., 94
Clutter, J. J., 217
Cole, C. V., 106
Cole, S., 17
Coleman, N. T., 80
Comes, R. D., 60
Cook, C. W., 211
Cooper, G. S., 90
Correll, F. E., 47
Cree, C. B., 109
Cullen, N. A., 174
Cummings, G. A., 47
Cunningham, M. D., 247

Dahl, J., 256
Dahms, W. G., 221
Daniell, R. E., 117
Das, A. C., 165
Dass, A. S., 150
Datta, N. P., 153, 163
Datta, N. R., 153
Davies, E. B., 174

Davidson, D. T., 65, 283
Davidson, V. E., 260, 268
Davis, R. D., 127
Davis, S., 186
Day, R. H., 31
De, S. K., 164
De Haan, F. A. M., 79
Degman, E. S., 94
Demirel, T., 65
DeWiest, R. H. M., 40
Division of Forest Economics Research, 223
Doneen, L. D., 182
Dortignac, E. J., 132
Drew, J. V., 114
Drezgic, P., 142
Driessche, R., van den., 225
Driscoll, R. S., 276
Duley, F. L., 122
Dutt, G. R., 182
Dylla, A. S., 59

Easterbrook, D. J., 116
Eby, H. J., 286
Edgerton, L. J., 235
Egbert, A. C., 246
Egerszegi, S., 195
Embleton, T. W., 100, 109
Emerson, F. B., Jr., 278
Enyi, B. A. C., 50
Erickson, H. R., 279

Fanning, C. D., 190
Fleming, J. W., 110
Flocker, W. J., 72
Foley, D. D., 280
Ford, H. W., 125
Forest Service, 227
Forshey, C. G., 85, 86, 95
Fortson, J. C., 205
Fouss, J. L., 56
Foy, C. L., 242
Fritschen, L. F., 68

Gabrilides, S. T., 66
Gamble, H. B., 275
Ganje, T. J., 99

Garcia, G., 132
 Garde, R. J., 27
 Gardner, H. R., 117
 Gary, H. L., 214
 Gautamdev, 161
 Gedney, D. R., 224
 Gersten, B., 111
 Ghosh, A. B., 168
 Ghosh, S. K., 154
 Glasglow, L. L., 277
 Godfrey, C. L., 118
 Goodall, G. E., 198
 Godell, B. C., 77
 Greer, K. R., 265
 Grimes, D. W., 49
 Gruell, G. E., 270
 Grunes, D. L., 106
 Guenther, E. L., 206
 Guenzi, W. D., 185

Haan, F. A. M., De., 79
 Haddock, J. L., 107
 Haise, H. R., 41
 Hallsworth, E. G., 104
 Harleman, D. R. F., 36
 Hatch, W. B., 12
 Hauser, V. L., 73
 Hawkins, J. C., 144
 Hayes, M. H. B., 119
 Heady, E. O., 246
 Heinselman, M. L., 219
 Henderson, H. A., 247
 Hennessy, T. E., 259
 Herron, G. M., 49
 Hickey, W. C., Jr., 132
 Hobbs, H. W., 1
 Hodgson, J. M., 60
 Hodgson, R. H., 281
 Hoffman, M. B., 235
 Howard, G. S., 229
 Howe, P. B., 24
 Hubbard, L. R., 15
 Hubbard, R. L., 213
 Huff, F. A., 193
 Hull, A. C., Jr., 171
 Hunter, A. H., 47
 Hussey, K. M., 126
 Hutchins, W. A., 52

Idnani, M. A., 156

Jacobson, L., 81
 Jarocki, W., 34
 Jayaram, N. S., 158
 Jensen, M. E., 41
 Jevtic, S., 142
 Johansen, C., 282
 Johanson, F. D., 97
 Johnson, C. M., 81
 Johnson, D. D., 138, 185
 Johnson, D. K., 108
 Johnson, G., 108
 Johnson, J. A., 13
 Johnson, M. L., 19
 Jones, D. S., 53
 Jones, J. N., Jr., 202
 Jones, W. W., 100, 109
 Jonkel, C. J., 265

Kadman, A., 189
 Kalamkar, V. G., 82
 Kallman, B. J., 258
 Kanwar, J. S., 151
 Kapusta, E. C., 172
 Kemper, H. M., 242
 Kenworthy, A. L., 101
 Khristeva, L. A., 137
 Koenigs, F. F. R., 67
 Kotova, V. V., 177
 Kozlowski, T. T., 218
 Krueger, K. W., 203
 Kubota, J., 105
 Kulp, J. W., Jr., 284
 Kuntze, G. L., 118
 Kushman, L. J., 112

Laase, G. R., 117
 Labamauskas, C. K., 100, 109
 Lag, J., 161
 Larson, N. G., 251
 Larson, W. E., 139, 141
 Lauritzen, C. W., 46
 Lavee, S., 201
 Lavin, F., 215
 Lawrence, T., 51
 Lee, B. W., 198
 Lee, R. E., 8
 Lee, W. O., 60
 Leggett, G. E., 96
 Lemon, E. R., 105
 Lent, J. D., 2

Leo, M. W. M., 188
 Leont'ev, A. M., 291
 Le Roux, F. H., 80
 Lewis, W. M., 254
 Leyden, R. F., 237
 Ligum, S. T., 133
 Lillard, J. H., 202
 Linville, A., 78
 Lockard, C. R., 222
 Longstaff, W. H., 173
 Lopinot, A., 254
 Lotspeich, F. B., 117
 Low, P. F., 75
 Lukyanenko, N. V., 137
 Lunin, J., 196
 Lusby, G. C., 3

Mc Clue, J. P., 271
 Mc Elroy, R. C., 241
 Mc Guinness, C. L., 21
 Mac Kenzie, A. J., 113, 292
 Maddy, J., 197
 Mader, D. L., 121
 Magness, J. R., 233
 Mandal, S. C., 155
 Marcusiu, E. C., 290
 Marlatt, W., 192
 Martin, J. P., 99
 Massee, T. W., 135
 Mateos, M., 283
 Mathers, A. C., 117
 Mayberry, B. D., 289
 Mayhew, J. K., 62
 Maynard, D. N., 111
 Meagher, M. D., 147
 Meelu, O. P., 151
 Mehta, B. V., 157
 Mehta, K. M., 82
 Melnikov, L. K., 291
 Menzel, R. G., 292
 Merrill, C. L., 12
 Michel, C., 70
 Middleton, J. E., 48
 Mihalic, V., 143
 Mikhnovskiy, V. K., 177
 Miller, J. H., 242
 Miller, R. J., 75
 Millet, J. L., 114
 Mishra, V. K., 160
 Misra, S. G., 170
 Moldenhauer, W. C., 197

Moody, J. E., 202
 Moorthy, C. K., 158
 Mortensen, J. L., 119, 136, 290
 Montgomery, G. G., 269
 Morton, E. S., 198
 Muckel, D. C., 46
 Munns, D. N., 81
 Murphy, F. W., Sr., 44
 Musick, J. T., 49
 Mussehl, T. W., 263
 Muth, O. H., 98
 Myers, L. E., 23, 58
 Myles, G. A., 59

Nair, P. K., 158
 Nash, V. E., 123
 Naskar, G. C., 169
 Neubauer, T. A., 208
 Nielson, D. R., 76
 Nilsson, K., 91
 Nixon, P. R., 73
 Nõmmik, H., 91
 Norton, J. S., 43

Odell, H. H., 18
 Ojakangas, R. W., 115
 Olsen, S. R., 84, 106
 Olson, E. O., 238, 239
 Osborn, H. B., 191
 Otto, N. E., 281
 Otte, P., 273
 Ounsworth, L. F., 243

Packer, P. E., 272
 Page, A. L., 99
 Papez, N. J., 270
 Pase, C. P., 215
 Patel, J. M., 157
 Patel, S. P., 168
 Pathak, T. C., 162
 Peterson, T. A., 218
 Phelan, J. T., 46
 Phipps, H. M., 231
 Pirozhenko, G. S., 134
 Polyakov, U. A., 291
 Porter, L. K., 106, 138
 Powell, J. D., 205
 Powell, J. V., 241

Prasad, C. R., 155
 Prickett, T. A., 37
 Proebsting, E. L., Jr., 236
 Pugh, W. J., 186
 Puntamkar, S. S., 82
 Putman, J. A., 222

Rai, A. K., 155
 Rajagopal, C. K., 156
 Rajan, S. V. G., 167
 Raju, K. G. R., 27
 Rao, B. V. V., 167
 Rao, K. K., 159
 Rao, T. M. V., 159
 Rao, W. V. B. S., 166
 Raudkivi, A. J., 28
 Raychaudhuri, S. P., 148
 Reginato, R. J., 68
 Reid, V. H., 3
 Reisenauer, H. M., 102
 Reiter, E. R., 287
 Repert, J. N., 210
 Resch, W. F., 187
 Reynolds, H. G., 131, 209, 274
 Reynolds, W. N., 191
 Rich, L. R., 131
 Riehl, H., 192
 Ripley, T. H., 271
 Rivers, E. D., 118
 Roberts, H., Jr., 292
 Robinson, A. R., 46
 Rockey, J. W., 285
 Roderick, G. L., 65
 Roe, E. I., 219
 Rogler, G. A., 204
 Rohrbaugh, P. W., 237
 Rollins, M. B., 59
 Romashkevich, A. I., 130
 Rovira, A. D., 93
 Rowe, P. B., 24
 Rumer, R. R., Jr., 36
 Runkel, S. T., 62

Sander, D. H., 230
 Sanderson, H. R., 213
 Saunders, F. B., 205
 Saveson, I. L., 54
 Schaaf, H. M., 204
 Schmidt, B. L., 197

Schoff, E. L., 199
 Schultz, R. K., 184
 Scott, R. S., 174, 175, 176
 Seegrist, D. W., 213
 Sen, S., 168
 Sharma, D. C., 169
 Sharma, J. P., 166
 Shiflet, T. N., 120, 228
 Shipman, R. D., 220
 Shrader, W. D., 197
 Siddoway, F. H., 200
 Simon, A. L., 35
 Singh, R., 151
 Sirur, S. S., 149
 Sitterly, W. R., 245
 Skryabin, F. A., 88, 178
 Smith, R. L., 90
 Snapp, O. I., 240
 Snodgrass, G. F., 57
 Soil and Water Conservation Research Division, 22
 Soil Conservation Service, 128
 Sposito, G., 78
 Springfield, H. W., 207, 212
 Srivastava, S. C., 163
 Ståhlberg, S., 103
 Stearns, F. W., 124
 Stebbins, R. L., 108
 Stein, M., 20
 Stempel, M. E., 267
 Stephens, J. C., 71
 Stewart, B. A., 138
 Stewart, E. H., 71, 292
 Stockinger, K. R., 113
 Stoddart, L. A., 211
 Subbiah, B. V., 165
 Sukhobrus, S. V., 134
 Sullivan, E. G., 260
 Summerfelt, R. C., 254

Tamboli, P. M., 160
 Taylor, H. M., 64, 117
 Teubner, F. G., 244
 Thomas, C. H., 277
 Thompson, C. B., 4
 Thompson, J. R., 3
 Tietjen, C., 179, 180, 181
 Timmons, F. L., 60
 Tovey, R., 45
 Tschinkel, H. M., 32

Tukey, R. B., 199
Turner, G. T., 3

Uhlig, H. G., 14
Unger, J. L., 42
United States Department of Agriculture, 248

Van Bavel, C. H. M., 68, 73
Van Camp, L., 259
van Dierendonck, F. J. E., 232
van Eck, W. A., 216
van't Woudt, B. D., 194
Vernell, H. F., 111
Vysotskaya, P. N., 177

Waddington, J. T., 244
Wadleigh, C. H., 10
Walker, C. R., 257
Walker, R. B., 97
Wallis, J. R., 2, 25
Walton, W. C., 37
Watanabe, F. S., 84
Weldon, L. W., 60
Welker, B. D., 253
Whiteside, E. P., 216
Wilcox, L. V., 187
Wilkerson, J. A., 242
Williams, D. A., 5
Wilson, D. O., 102
Winter, E. J., 74
Wischmeier, W. H., 129
Woodruff, C. B., Jr., 9
Woodruff, N. P., 200

Woolfolk, E. J., 210
Worthington, E. L., 11
Wright, V., 273
Wu, I-P., 30

Yadav, J. S. P., 162
Yamamoto, T., 69
Yashouv, A., 252
Yates, M. G., 104
Yeo, R. R., 60
Yevdokimova, T. I., 92
Young, R. E., 111
Young, R., 238, 239

Zakharchenko, I. G., 134

